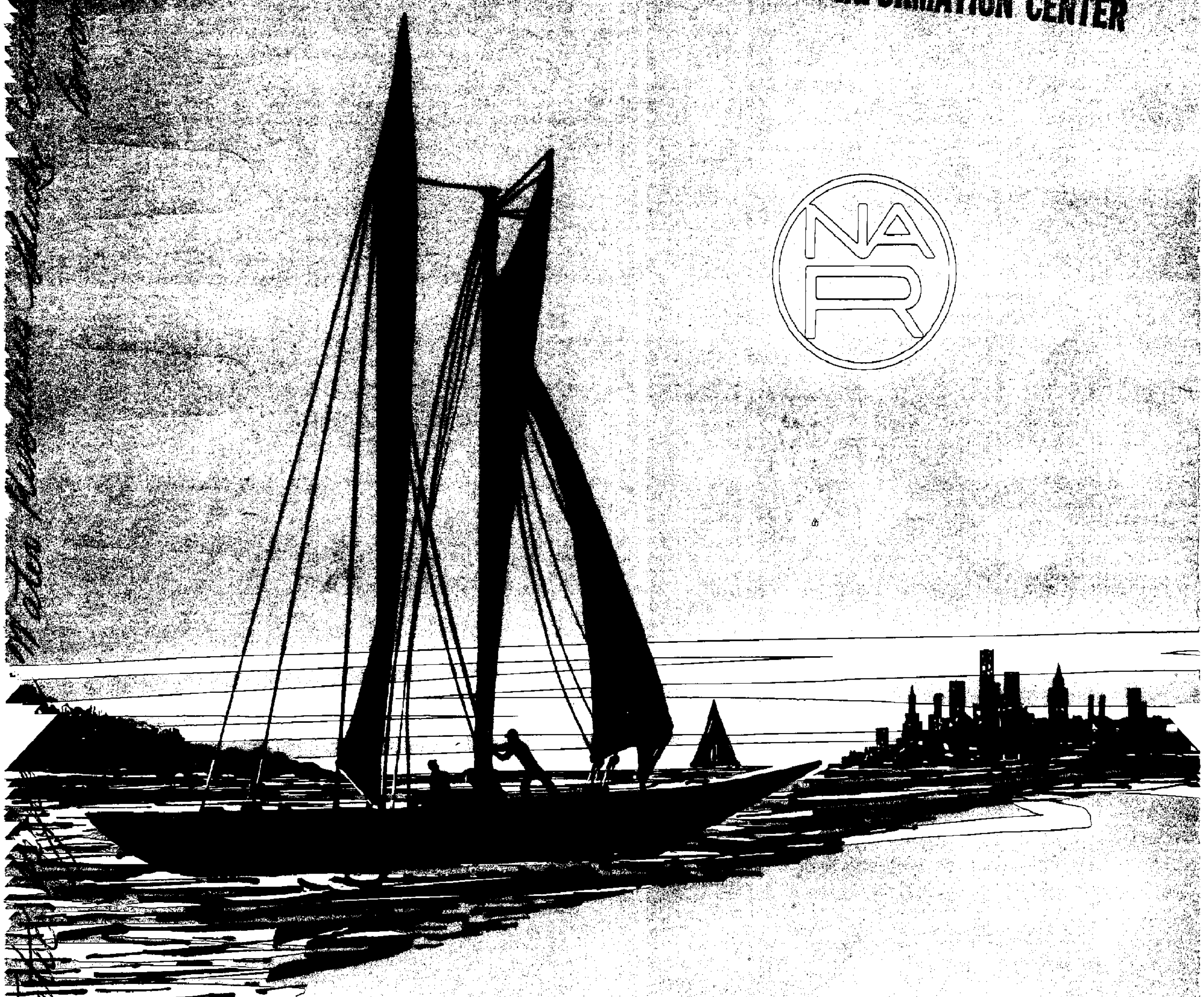
North Atlantic Regional
Water Resources Study

Appendix U
Coastal and Estuarine Areas

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

MAY 1972

North Atlantic Regional Water Resources Study



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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

MAY 1972

The North Atlantic Regional Water Resources (NAR) Study examined a wide variety of water and related land resources, needs and devices in formulating a broad, coordinated program to guide future resource development and management in the North Atlantic Region. The Study was authorized by the 1965 Water Resources Planning Act (PL 89-80) and the 1965 Flood Control Act (PL 89-298), and carried out under guidelines set by the Water Resources Council.

The recommended program and alternatives developed for the North Atlantic Region were prepared under the direction of the NAR Study Coordinating Committee, a partnership of resource planners representing some 25 Federal, regional and State agencies. The NAR Study Report presents this program and the alternatives as a framework for future action based on a planning period running through 2020, with bench mark planning years of 1980 and 2000.

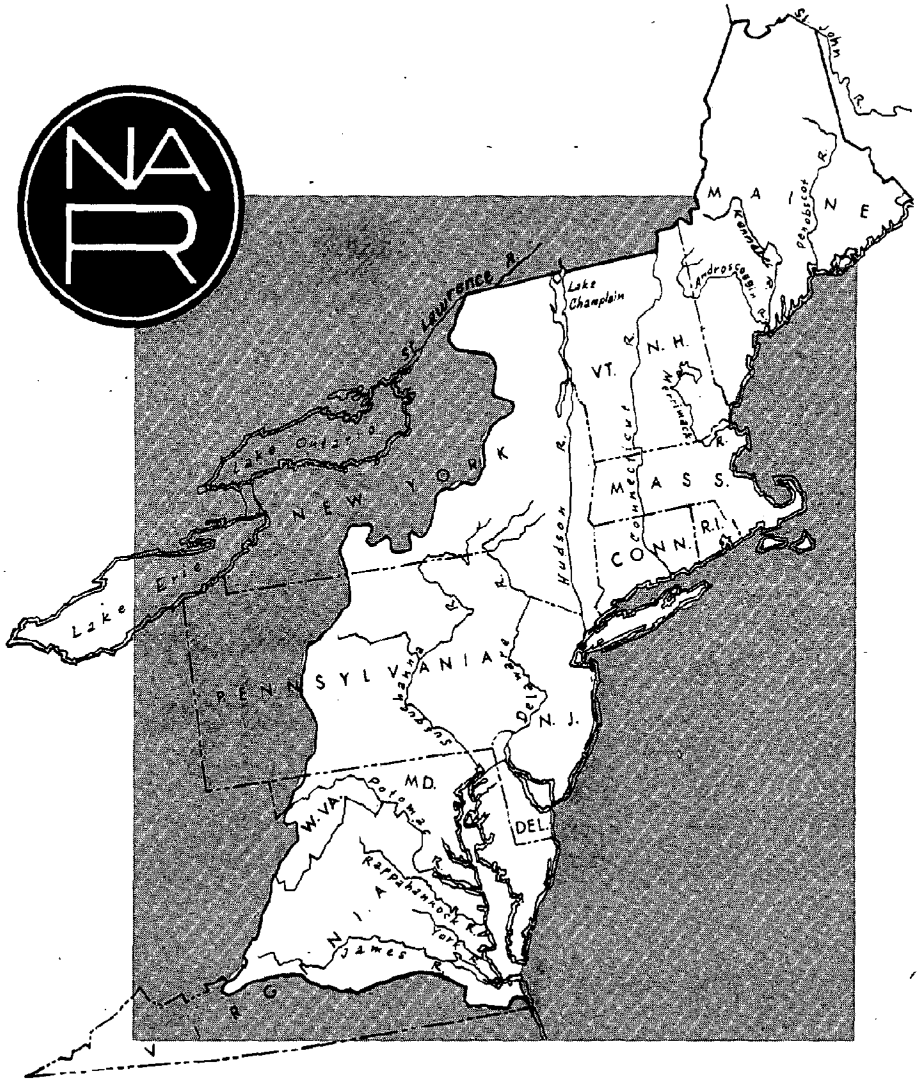
The planning partners focused on three major objectives -- National Income, Regional Development and Environmental Quality -- in developing and documenting the information which decision-makers will need for managing water and related land resources in the interest of the people of the North Atlantic Region.

In addition to the NAR Study Main Report and Annexes, there are the following 22 Appendices:

A. History of Study
B. Economic Base
C. Climate, Meteorology and Hydrology
D. Geology and Ground Water
E. Flood Damage Reduction and Water Management for Major Rivers and Coastal Areas
F. Upstream Flood Prevention and Water Management
G. Land Use and Management
H. Minerals
I. Irrigation
J. Land Drainage
K. Navigation
L. Water Quality and Pollution
M. Outdoor Recreation
N. Visual and Cultural Environment
O. Fish and Wildlife
P. Power
Q. Erosion and Sedimentation
R. Water Supply
S. Legal and Institutional Environment
T. Plan Formulation
U. Coastal and Estuarine Areas
V. Health Aspects

WATER RESOURCES NEEDS AND POTENTIALS FOR AN EXPANDING SOCIETY

Appendix U
Coastal and Estuarine Areas



Prepared by

The Center for the Environment and Man, Inc.
Hartford, Connecticut

for the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

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SELECTED PROBLEMS
(Numbers in boxes refer to page location)

Problems	Nature of the Problem	Major Causes	Location	Time Characteristics	Parties Affected	Solutions 1/
Living resources	43	44	46	46	46	47
Conservation of wetlands	49	50	52	53	53	54
Non-living resources	56	NA	NA	NA	NA	NA
Water pollution	63	64	71	73	74	77
Thermal effects	98	99	99	100	103	103
Solid wastes disposal	110	110	112	112	112	113
Recreation	116	116	118	119	119	120
Marine transportation	122	124	127	131	131	137
Coastal erosion and tidal flooding	149	149	155	157	157	159

1/ "Solutions" include such considerations as solution identification; costs and benefits, direct and indirect; organizational aspects, effectiveness, establish goals, determine sources and establish controls.
2/ "NA" means that the coverage was integrated with the text, not explicitly broken out.

REGIONAL SUMMARY
(Numbers in boxes refer to page location)

Areas	Area Characteristics	Major Coastal Uses	Major Coastal Problems	Major Prospects and Potentials
Subregion A	--	--	169	--
Area 5	170	171	175	176
Subregion B	--	--	179	--
Area 6	180	181	184	185
Areas 7 & 9 (Mass.)	187	188	190	191
Area 9 (R. I.)	192	193	195	196
Areas 8 & 10	198	199	200	201
Subregion C	--	--	203	--
Area 13 (L. I.)	204	205	207	212
Areas 12 & 13 (NYC)	214	215	216	217
Subregion D	--	--	219	--
Area 14	220	220	221	222
Area 16	223	224	224	225
Area 15	227	228	229	230
Subregion E & F	--	--	232	--
Areas 18, 19, 20, 21 (Ches. Bay)	234	236	238	247
Areas 18 & 21 (Ocean)	249	250	250	252

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SYLLABUS

The broad objective toward which this appendix is written is to maintain and improve the usefulness of the coastal zone to man for now and for the future. This objective is approached from the point of view of planning and managing the wise use of the coastal water and related land resources. Major coastal uses are seen as the extraction of living and non-living resources, waste disposal, recreation and aesthetics, transportation, national defense and coastal land use.

Many basic considerations justify special coastal planning and management attention, particularly at the state level. Current and predicted demand for coastal uses is exceptionally high. The coastal zone's resource base is very limited. Significant conflicts abound between coastal zone uses and between coastal and non-coastal uses, especially inland uses. Non-market factors of indivisibilities, externalities and irreversibilities are very prominent. Important knowledge gaps exist. Decisions must be made. Basic responsibilities are split in a variety of organizational patterns.

Proceeding from this overview nine major problem areas are selected for special analysis, partially on the basis of numerous interviews throughout the region. These problem areas are living resources, conservation of wetlands, non-living resources, water pollution, thermal effects, solid waste disposal, recreation, marine transportation, and coastal erosion and tidal flooding. For each of these problems, its nature, causes, and location and time characteristics are outlined; activities affected by the problem are identified and general solutions are considered in the broad context of planning and managing the region's water and related land resources. Interrelations of the coastal zone with its neighbors, both inland and oceanward are given special attention. Of the nine selected problems, water pollution and the conservation of wetlands appear at this time to be most prominantly recognized throughout the region.

Each area of the NAR coastal zone is reviewed in terms of its physical and socio-economic characteristics, its major coastal uses and problems, and its prospects and potentials. An overview of coastal erosion and tidal flooding is given for each area, since only selected aspects of this subject are covered in other appendices to the NAR Study.

INTRODUCTION

APPROACH

The "coastal zone" is a geographic concept. It encompasses the oceanward flank of the North Atlantic Region (NAR) for nearly 1000 miles. As such it cuts across many boundaries--geographic, functional and institutional. Geographically it includes all five of the NAR's sub-regions and 19 of its 21 areas. Essentially all of the NAR's functional appendices apply in substantial measure to it. Institutionally, almost every Federal agency, all but two of the region's 13 states and a multitude of lower levels of government are carrying out their particular roles within it, just as they do in other geographic sectors.

Against such a backdrop, it becomes especially important to define an approach to the coastal appendix. If the appendix is not to be all things to all people--and thus lose meaningful focus--it must be limited to an essential digestible core. The initial entry point must be very broad, yet this entry point must lend itself to rapid focus on those components where attention seems most profitable.

The coastal appendix seeks to meet these requirements by--

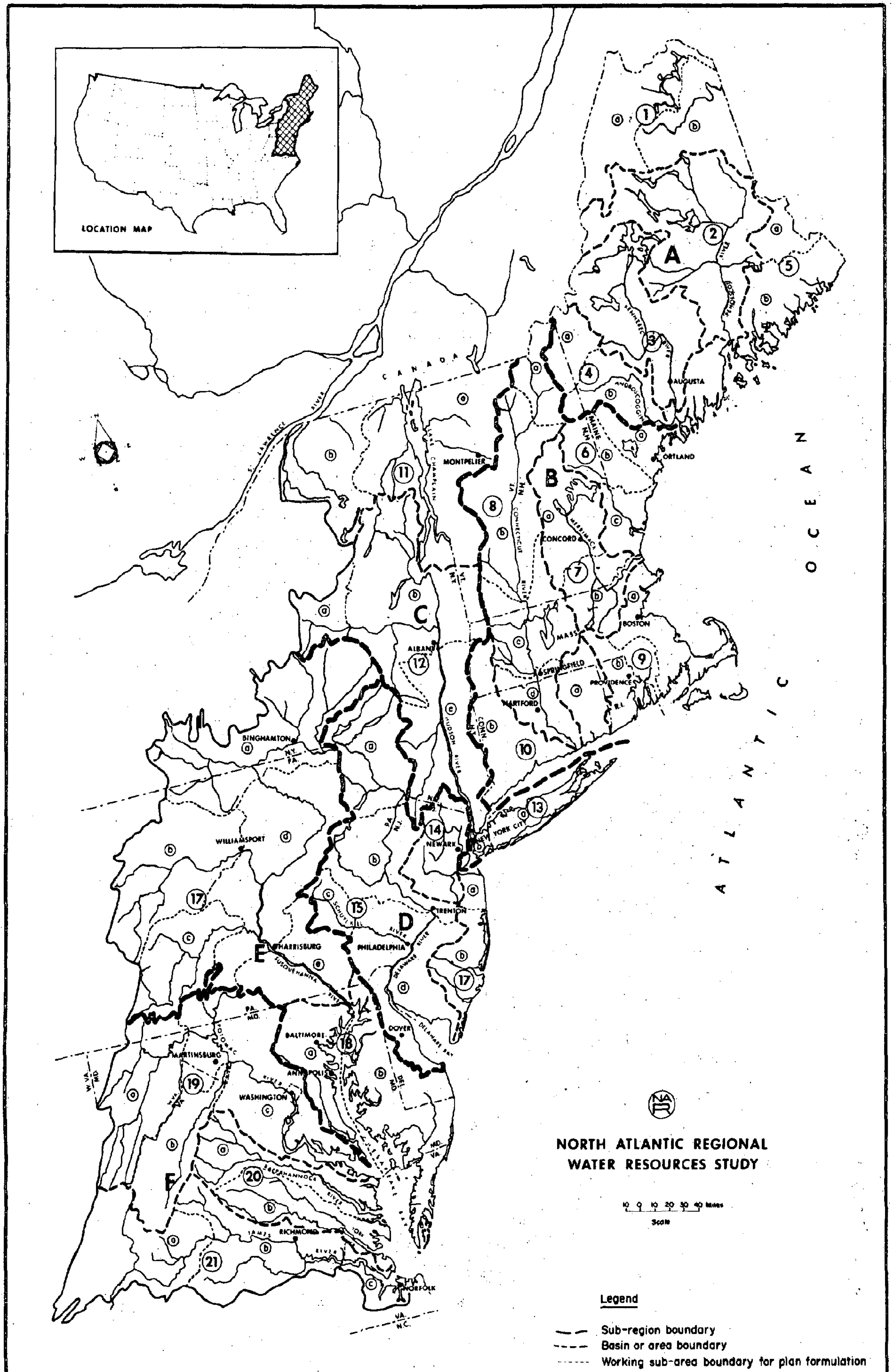
- Setting the stage with a broad, use-oriented objective and examining its meaning.

- Developing a structure of coastal uses and of inputs for achieving these uses.

- Selecting some major problems in achieving these uses for further analysis.

- Defining and describing these selected problems and suggesting possible solutions.

- Applying the foregoing analysis to delineated segments of the coastal zone.


LOCATION MAP
NORTH ATLANTIC REGIONAL
WATER RESOURCES STUDY
Scale
Legend
Sub-region boundary
Basin or area boundary
Working sub-area boundary for plan formulation
ATLANTIC OCEAN
CANADA
AUGUSTA
PORTLAND
MONTPELIER
CONCORD
BOSTON
SPRINGFIELD
PROVIDENCE
HARTFORD
ALBANY
BINGHAMTON
WILLIAMSPORT
NEWARK
NEW YORK CITY
TRENTON
HARRISBURG
PHILADELPHIA
DOVER
BALTIMORE
ANNAPOLIS
MARTINSBURG
WASHINGTON
RICHMOND
NORFOLK
A
B
C
D
E
F

OBJECTIVE

As the initial starting point, the broad objective chosen was:

> To maintain and improve the usefulness of the coastal zone to man for now and for the future.

Like all broad objectives, each of its terms requires reflection and understanding. It is thus worth lingering at the outset on these terms, for the overall purpose of this appendix is to give substance and depth to them in a way which can facilitate decision.

"To maintain and improve" implies value judgments. It is not always clear in which direction "improvement" lies. Current conditions might be preferable. Thus a rational approach to the coastal zone begins with the aspiration that it is possible to discern whether improvement is desirable and in which direction it lies, that people inputs will be necessary to assist in this discernment.

"Usefulness" can also vary with the point of view, again requiring reflection on ways these different viewpoints can be identified, considered and hopefully harmonized. "Usefulness" also introduces the question, "what are the uses?" In response, a family of uses will be developed later to facilitate further analysis and provide a framework helpful for articulating and distinguishing human values.

"Of the coastal zone" introduces the requirement to define at the outset the geographic span of attention. No definition of the coastal zone can satisfy all requirements,because the zone is a transition from land to sea and the influence of their interface never entirely disappears anyplace on earth. However, since the intensity of this influence does diminish perceptively as one moves landward or seaward from the shoreline, it is possible and useful to suggest limits which will satisfy most requirements reasonably well. The definition adopted is one which sacrifices slightly some environmentally desirable attributes in order to incorporate some important political dimensions. As used herein the coastal zone is defined as "that geographic area bounded on its seaward side by the outer limits of state jurisdiction and on its landward side by the inland limits of significant marine influences, as defined by the individual states." The process of defining the inland limits and the difficulty in doing so introduces a strong reminder that the coastal zone is not an island unto itself. Concentration on solutions to coastal zone problems must be tempered with an awareness of adjacent inland and oceanic perspectives, if suboptimal solutions are to be avoided. Put another way "the usefulness of the coastal zone to man" must be improved within the context of a combined coastal-and-non-coastal perspective. One way of minimizing unintentional suboptimization is to imbed the coastal zone analysis in a larger context, as is being done in the overall NAR study.

"To man" is intended in its broadest sense. Certainly the term does give emphasis to satisfying the most obvious physical, social and aesthetic needs of man such as his needs to supply himself with food and materials and to enjoy himself. However, as used herein it is also intended to reflect the growing awareness that inadequate concern for the natural environment as a whole can react unfavorably and often surprisingly on man himself. Our concern for the eco-system, for example, is founded on the belief that it is important to man, even though the relationship is often indirect and poorly understood.

"For now and for the future" provides a reminder that both perspectives must be included. It implies a pervading need to foresee the long-term consequences of current actions and yet still make "now" decisions, whether for action or postponement, when visibility of the future is obscured. Predictive techniques need priority attention, but equally important, people input is essential to answer the eternal question--"Do we know enough to proceed?"

METHODOLOGY

This appendix was prepared in six phases.

In the first phase non-structured letters were sent to a number of knowledgeable people throughout the North Atlantic Region. The addressees were selected to obtain a wide variety of informed opinion about coastal problems in the region. Thirty-three replies were received. The study of these replies was combined with staff experience to develop an initial system of coastal uses and problems along with a system of descriptors for describing the problems and potential solutions.

The second phase was information acquisition. It was built about personal interviews and literature research.

A list of interviewees was developed and screened to insure balance in geographic areas, in major coastal uses and in institutional levels to include Federal, state, local, academic and business perspectives. Letters were sent to those selected to establish rapport and convey an initial understanding of the purpose of the interview, the problems being considered and the tentative system for describing these problems and their solutions. Interview sheets were developed to record and code the interviews systematically. The response was gratifying. Deep appreciation is extended to those who contributed so graciously to this undertaking. Table U-1 is a list of 164 people formally interviewed. Many others were seen or contacted by phone in the course of the work and contributed useful information and perspectives.

Material for literature review was obtained by the staff. Many useful suggestions as to pertinent literature were obtained from the interviewees. Each document was reviewed and those judged most meaningful were summarized and coded using the interview sheets.

The third phase was analysis. Based upon a study of the information acquired earlier, the system of uses was refined, a final selection of problems was made and the list of descriptors was consolidated and simplified. Information was extracted and synthesized to provide a general problem overview and a unified description and analysis of the selected problems. Interrelationships with other aspects of water and related land resources in the region as a whole were given special attention during this analysis.

The fourth phase was the problem writeup. Each problem was described in terms of its nature and severity, its causes, its locational and time characteristics and the parties affected by it. Type solutions were then identified and discussed in terms of their direct and indirect effects and organizational implications.

In the fifth phase the coastal zone was divided into segments using boundaries consistent with those established for the overall NAR study. For each of these segments a brief summary was prepared depicting its chief physical and socio-economic characteristics of coastal significance and its major coastal uses, problems, prospects and potentials. For those problems considered to be of major significance a brief discussion was provided to apply the earlier general problem analysis to the particular coastal area.

In the sixth or cleanup phase, drafts were reviewed by the sponsor, an annotated bibliography was developed, and the appendix was prepared in final form.

TABLE U-1
PERSONS INTERVIEWED
(Organizational affiliations were those at the time of the interview.)

Anthony F. Abar - Department of Water Resources, Maryland
Mark Abelson - U.S. Department of the Interior
Richard Ackeley - New Jersey Soil Conservation Service, U.S. Department of Agriculture
Donald Adams - Environmental Improvement Commission, Maine
Julian Alexander - Department of Conservation and Economic Development, Virginia
Dr. Lewis M. Alexander - University of Rhode Island
Donald D. Allen - American Association of Port Authorities
Leo Allen - State Senator Moakley's Office, Massachusetts
Paul A. Amundsen - American Association of Port Authorities
Norris C. Andrews - Regional Planning Agency of South Central Connecticut
Dr. William I. Aron - Smithsonian Institution
Elmore Ballard - Ballard Brothers Seafood Company
Nicholas L. Barbarossa - Department of Environmental Conservation, New York
Joseph Barber - Department of Environmental Protection, New Jersey
Ernest T. Bauer - Virginia Port Authority
Fred Beck - Callahan Mining Company
William S. Beller - Office of Marine Affairs, Department of Interior
Derekson Bennett - American Littoral Society
Bruce Birnhack - Bureau of Sport Fisheries and Wildlife
Richard J. Bouchard - Department of Transporation
Capt. Fletcher W. Brown, Jr. - U.S. Coast Guard, Boston
Roy L. Brown - Department of Conservation and Economic Development, Virginia

TABLE U-1 (cont'd)

Arthur W. Brownell - Department of Natural Resources, Massachusetts
Thomas Bruha - U.S. Army Corps of Engineers, Waltham
B. Calvin Burns - Prince William Engineering Company
Robert Burns - National Park Service
Walter E. Butler - U.S. Army Corps of Engineers, New York
Francis Carboine - Federal Aviation Administration
Richard Carpenter - Southwest Regional Planning Agency, Connecticut
D. J. Cederstrom - U.S. Geological Survey
Dr. Charles J. Cicchetti - Resources for the Future
John J. Coffey - Chamber of Commerce of the United States
Kenneth Compton - Bureau of Outdoor Recreation
Elbert Cox - Commission of Outdoor Recreation, Virginia
Dr. L. Eugene Cronin - Chesapeake Biological Laboratory
Robert Cyphers - Department of Environmental Protection, New Jersey
David Damon - Bureau of Sport Fisheries and Wildlife
Harold Davis - Department of Shellfishing, Maryland
Dr. David Dean - University of Maine
Louis E. DeCamp - Federal Water Quality Administration
Richard S. De Turk - Tri-State Transportation Commission
Dr. John W. Devanney - Massachusetts Institute of Technology
Robert L. Dow - Department of Sea and Shore Fisheries, Maine
Calvin Dunwoody - Department of Natural Resources, Rhode Island
William J. Duddleson - The Conservation Foundation
Leslie Dyer - Maine Lobsterman's Association
Howard H. Eckles - Office of Marine Affairs, Department of Interior
Commander N. P. Ensrud - U.S. Coast Guard, Washington
Richard B. Ericson - Southeastern Connecticut Regional Planning Agency
George Ferguson - U.S. Geological Survey
Arthur Flickinger - Soil Conservation Service, U.S. Department of Agriculture
Charles H. W. Foster - New England Natural Resources Center
Ernest Friday - Department of Community Affairs, Rhode Island
William Gannon - U.S. Lines, Inc.
Lemuel Garrison - National Park Service
Edson B. Gerks - Connecticut Development Commission

TABLE U-1 (cont'd)

Boyd H. Gibbons - Council on Environmental Quality
Thomas R. Glenn, Jr. - Interstate Sanitation Commission
Rear Admiral Robert W. Goehring - Chief of Staff, U.S. Coast Guard, Washington
Dr. Morton Gorden - Development Sciences, Inc.
Malcolm Graff - New England River Basins Commission
Stanley V. Greiman - Connecticut River Estuary Regional Planning Agency, Connecticut
Dr. Walter J. Grey - NEMRIP, University of Rhode Island
Frank Grice - Department of Natural Resources, Massachusetts
Richard E. Griffith - Bureau of Sport Fisheries and Wildlife
Jack D. Gunther - Connecticut Association of Conservation Commissions
Stuart O. Hale - University of Rhode Island
Mary Louise Hancock - State Planning Office, New Hampshire
Roland Handley - Bureau of Outdoor Recreation
R. J. Harding - Department of Environmental Conservation, New York
Dr. William J. Hargis, Jr. - Virginia Institute of Marine Science
Capt. David Hart - Atlantic States Marine Fisheries Committee
Robert R. Haslam - Humble Oil and Refining Company
Capt. Francis D. Hayward - U.S. Coast Guard, Washington
John Healey - Southeastern Regional Planning and Economic Development District, Massachusetts
Jean Hennessey - New Hampshire Charitable Fund
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John Holsten - Bureau of Commercial Fisheries
Joseph Ignazio - U.S. Army Corps of Engineers, Waltham
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William Jobin - Department of Natural Resources, Massachusetts
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Norman Kapka - Department of Forests and Waters, Pennsylvania
Dr. Robert Kay - National Council on Marine Resources and Engineering Development
Dr. S. Russel Keim - National Academy of Engineering
Charles F. Kennedy - Department of Natural Resources, Massachusetts

TABLE U-1 (cont'd)

Harold Kimball - State Planning Office, New Hampshire
Dr. John A. Knauss - University of Rhode Island
Ralph F. Kresge - U.S. Weather Bureau
Robert Krieger - National Aeronautics and Space Administration
George Lamb - American Conservation Association, Inc.
Edward Lane - Department of Natural Resources and Environmental Control, Delaware
Donald E. Lawyer - Office of the Chief of Engineers, U.S. Army
Major Robert Lindsay - U.S. Army Corps of Engineers, New York
Robert B. MacKinnon - U.S. Corps of Engineers, Waltham
Burt MacLean - Office of the Chief of Engineers, U.S. Army
Howard J. Marsdon - Maritime Administration
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James Murphy - U.S. Dredging Corporation
Mr. Nelson - Eastern Sea Frontier, U.S. Navy
Walter Newman - New England River Basins Commission
Earl Nichols - Bureau of Outdoor Recreation
Rear Admiral Harley D. Nygren - Environmental Science Services Administration
Theodore Olcott - Port of New York Authority
F. S. Oldham - Department of Forests and Waters, Pennsylvania
Lincoln R. Page - U.S. Geological Survey
F. L. Panuzio - U.S. Army Corps of Engineers, New York
Neil Parker - Office of the Chief of Engineers, U.S. Army
Capt. Forest Pease - Eastern Sea Frontier, U.S. Navy

Capt. Carl F. Pfeiffer - Maritime Administration, New York
Ron Poitras - Maine State Planning Office
James Rankin - Department of Environmental Protection, New Jersey
Philip Savage - Maine State Planning Office
Thorndike Saville - Coastal Engineering Research Center, U.S. Army
Thomas Schrader - Bureau of Sport Fisheries and Wildlife
Harry Schwarz - U.S. Army Corps of Engineers, New York
Margaret Seeley - National Association of Counties
Sidney Shapiro - Long Island State Park Commission
Dr. Lois K. Sharpe - League of Women Voters of the United States
John W. Sherman, III - U.S. Naval Oceanographic Office
Paul Shore - Federal Power Commission
Fred Sieling - Maryland Natural Resources Management Division
Joseph Smurda - Department of Health, Pennsylvania
A. J. Somerville - Department of Forests and Waters, Pennsylvania
Mary B. Sowchuk - Greater Bridgeport Planning Agency, Connecticut
Harry A. Steel - Water Resources Council
Charles G. Stone - U.S. Army Corps of Engineers, New York
George S. Swarth - Department of Justice
Richard Symonds - Office of State Planning, Connecticut
Julian Terrant - Commission of Outdoor Recreation, Virginia
Jack Thompson - Governor's Office, Rhode Island
Joseph Toland - Bureau of Outdoor Recreation
Joseph Truncer - Department of Environmental Protection, New Jersey
Robert Vandivert - Conservation Planners, Inc.
G. H. Van Gunten - U.S. Army Corps of Engineers, New York
Danial Varin - Rhode Island Statewide Planning Program
Blair Wakefield - Virginia Port Authority
Ian Walker - Stony Brook - Millstone Watershed Association, New Jersey
David Wallace - Department of Environmental Conservation, New York
Clint Watson - Department of Natural Resources, Massachusetts
Eugene W. Weber - International Joint Commission, with Canada
Mr. Weinstein - U.S. Army Corps of Engineers, New York
James Wentz - Maritime Administration, New York
Richard Weston - New England Regional Commission

TABLE U-1 (cont'd)

LTC Edward M. Willis - Coastal Engineering Center, U.S. Army
Peter Wilson - National Association of Engine and Boat Manufacturers
Hall Winslow - Tri-State Transportation Commission
Robert Wood - Tri-State Transporation Commission

COASTAL USES

As stated earlier, this appendix is directed toward the fulfillment of a broad objective, "to maintain and improve the usefulness of the coastal zone to man for now and for the future." In harmony with the overall NAR study, planning for the preservation, use and development of the zone's water and related land resources is seen as a fundamental means of achieving this objective.

To begin to add substance to the objective this section provides an answer to the question--"What are the human uses of the coastal zone?" A family of coastal uses is formulated, general inputs man must contribute to better achieve these uses are outlined and the two are organized into a framework useful for evaluating coastal problems. Some of the market and non-market values associated with the coastal uses are suggested. Lastly, two of the uses not explicitly developed later in the problem analyses are discussed briefly.

Uses. As the first step in identifying coastal uses it is important to recognize that although almost all forms of human activity can be found in the coastal zone, a fairly discernable few seem to be prominently and directly influenced by "coastalness"--the influence of the land-ocean interface.

On the basis of much structuring and restructuring and exposure to many people of various levels of government and non-government, it was concluded that man uses the coastal zone generally as follows:

- He gets things he wants from it both living and non-living--resource extraction.

- He puts things into it which he does not want--resource return, or more conventionally: waste disposal.

- He derives pleasure from it in the form of recreation and aesthetic satisfaction--enjoyment.

- He uses it to facilitate the movement of things and people--transportation.

It may be possible to associate almost any coastal use within these four broad classifications. However, in doing so two common use concepts would lose a visibility which might needlessly complicate later analysis. These two are land use and national defense.

Purely speaking land use can probably be demonstrated to be a complex mix of the four broad uses cited earlier. But by eliminating land use, it would become exceedingly difficult to grapple with problems such as access and zoning. For the sake of workability, then, the appendix sacrifices some possible analytical purity and incorporates land use into its structure of uses. Whenever practicable, however, one of the first four uses is preferred. Thus recreational land use is addressed primarily under recreation, not land use.

Similarly, the national defense use of the coastal zone can probably be ascribed principally to coastal transportation aspects, either to faciliate desired military movements or obstruct undesirable hostile movements. However imbedding national defense primarily within transportation would, like land use above, cause a cumbersome loss of focus on a major use of the coastal zone, especially offshore.

Without belaboring the intermediate steps the above thoughts can be translated into the following coherent system of uses:

RESOURCE EXTRACTION
- Living resources
    - Animal
        - Fish--finfish, shellfish, etc.
        - Land animals
        - Other--birds, amphibians, etc.
    - Vegetable--kelp, eelgrass, etc.
- Non-living resources
    - Solid materials--sand, gravel and other minerals
    - Liquid materials--oil, water, drugs, etc.
    - Gaseous materials
- Energy--tidal, wave forces, etc.

WASTE DISPOSAL
- Solid wastes
- Liquid wastes
- Thermal wastes
- Other wastes, e.g., radionuclides

ENJOYMENT
- Recreation
    - Primarily water-based
        - Water-contact sports
        - Sports fishing
        - Boating
        - Other
    - Primarily land-based--hunting, etc.
- Aesthetic satisfaction
    - Sensually perceptible--scenic, cooling, fresh air inhalation, etc.
    - Supraperceptible--general feeling of well-being

TRANSPORTATION
- Marine--harbors, channels, ports, terminals
- Land--coastal highways and rail lines
- Air--coastal airports

LAND USE
Private--primarily residential
Commercial
Industrial--coastally located primarily because of resource extraction, waste disposal or transportation considerations
Other--governmental, institutional, etc.

NATIONAL DEFENSE

It is easy to break this system down into any desired level of detail as indicated by the illustrative entries after the double dashes (--).

The set of uses seems reasonably complete, but one could add if he wished an additional category, "other uses," to serve as a catch-all. It was not found necessary to do so in this appendix.

Inputs. The uses outlined above may broadly be considered as coastal outputs--what man gets out of the coastal zone. To achieve these outputs man must--

- Identify and locate them.
- Preserve them to insure continued availability for the future.
- If their values are sufficiently important, increase their plentifulness or quality over that available in nature. He might for example, engage in mariculture (forming of the ocean) or improve a channel or beach.
- Lastly, use, harvest or consume that which he has located, preserved and enhanced above.

The overall objective chosen earlier contains a reminder to consider the future if coastal uses are to be perpetuated. Man can do this only by attention to all four of the above inputs. To focus on the last, the attractive payoff, is shortsighted.

Framework. Integrating the above set of uses (outputs) with the above set of activities (inputs) yields the framework of Figure U-2, shown here in condensed form without the numerous subuses developed earlier.

With some imagination the interrelationship of many activities and uses can be displayed on the framework. Thus, research and coastal engineering are not shown as uses. They are means to an end and their value lies ultimately in how they improve the coastal uses through identification, preservation, enhancement and harvesting these uses. They are thus brought out as useful tools which should be handy in resolving problems later. As a further illustration, the exercise of a certain regulatory control may be seen as a means to preserving a certain use.

COASTAL FRAMEWORK

OUTPUT (USES)	INPUT (ACTIVITIES)			
	Locate, identify	Preserve, conserve	Enhance, improve	Use, harvest, consume
RESOURCE EXTRACTION				
Living resources				
Non-living resources				
Energy				
WASTE DISPOSAL				
Solid				
Liquid				
Thermal				
Other				
ENJOYMENT				
Recreation				
Water-based				
Land-based				
Aesthetic satisfaction				
TRANSPORTATION				
Marine				
Land				
Air				
LAND USE				
Private				
Commercial				
Industrial				
Other				
NATIONAL DEFENSE				

SOURCE: Adapted from (31)[1/]

1/ The numbers in parentheses throughout this appendix (APPENDIX U) refer to the annotated bibliography found at the end of this appendix.

FIGURE U-2

GENERAL NATIONAL VALUES OF MAJOR COASTAL USES

Use	Direct market value		Some non-market values
	Estimated annual value ($ billion)	General basis of estimate	
Commercial fishing	$ 0.4	Dockside value of catch. Excludes sport fishing.	Preservation of a way of life, providing some of man's animal protein needs, international balance of payments.
Extraction of non-living resources	$ 1.7	Primarily, value of leases, drilling and product as it crosses coastline. Most ($1.6 billion) is crude oil and gas.	Internal self sufficiency, international balance of payments.
Waste disposal	$ 0.4	Primarily construction and operation of waste treatment facilities within 50 miles of coast. Probably grossly understated.	Environmental quality for other uses, especially fishing and recreation
Recreation & aesthetic satisfaction	$ 3.9	Cost of food, lodging, transportation, gear, entrance fees, boats, licenses, etc. Includes sports fishing.	Emotional well-being, physical fitness, health.
Transportation	$11.3	Marine transportation only. Includes port revenues plus freight revenues for portion of shipments which occur in coastal areas. Excludes $2.2 billion in shipbuilding.	Political relations with other nations, national defense, economic well-being of major population centers, international balance of payments.
National defense	$ 1.3	Navy: Operation and maintenance of coastal transport and antisubmarine warfare, construction and operation of coastal facilities. Coast Guard: Operations plus new facilities and equipment.	International relations.
Land use	Not estimated	--	U.S. tradition of land ownership and individual rights.

NOTES:

1. Data are 1964 except transportation which is 1963.
2. Detailed comparisons among uses is impracticable. Note that bases of the estimates differ significantly. Thus, if the cost of the processed and distributed fish products were used, commercial fishing would show at about $1.1 billion. In a somewhat similar manner, transportation shows only the coastal value added. The total value of the produce moved is much higher, $41 billion in 1968 for example.
3. Land use values, unestimated herein because of definitional problems, are probably very high. For example, the assessed valuation of new offshore land created by landfill off downtown Manhattan is about $2 billion.

SOURCE: Economic values adopted from basic information reported in (9).

FIGURE U-3

This framework can serve as a checklist in flagging water and related land resource actions which can maintain, improve or otherwise affect coastal uses. For example, Column 1 (Locate, identify) reminds the planner to evaluate such things as when and where the use occurs, its intensity, and its visible and latent demand. Column 2 (Preserve, conserve) reminds the planner to examine what natural and human factors, current and predictable tend to degrade the use and to examine what can be done about them. Column 3 (Enhance, improve) causes the planner to reflect on what can be done to increase the level of human satisfaction if this is desired. Column 4 (Use, harvest, consume) causes the planner to reflect on the efficiency with which the use is being captured. Sometimes he might find that the rate or method of capture is feeding back adversely on the earlier input stages, such as preservation of the resource base. (A case in point is fishing quotas.)

The framework can be useful in identifying conflicts between uses. For example, to improve transportation channel dredging might be necessary. The planner can then inquire systematically how this activity could affect other uses and thus take appropriate precautions or add perspective to a tradeoff decision.

Lastly, the framework can remind the planner that some of these use requirements can be satisfied in slightly different form elsewhere. For example, outdoor recreation demand, say for boating, can also be satisfied for certain classes of boats by inland resources. An understanding of these relationships is important to comprehensive coastal planning.

Values of Coastal Uses. It is not yet feasible to provide a fully acceptable assessment of the relative values of the major coastal uses. Before that can be done well, much greater understanding of human values and more precise and uniform definitions will be needed. Notwithstanding these limitations, however, some good attempts have been made to assign order-of-magnitude values to coastal uses. It is not hard to find in professional literature, valid objections to every one of these efforts. Figure U- 3 summarizes one study of coastal values. It is presented not as an endorsement of its technical purity, but in the belief that some understanding of use values is essential in a study like this, despite the fact that these values have not reached a maturity which merits a near unanimous professional endorsement. In reviewing Figure U- 3 attention is invited to the general basis for each estimate. Changing these bases will, of course, change the estimated values.

National Defense. It is beyond the scope of the overall NAR study and this appendix to consider problems in improving the defensive characteristics of the region's coastal zone. However, the impact of the national defense use upon other coastal uses is rather significant especially in the fields of research, economic impact, and the use of shorefront and offshore areas. Since they are not developed elsewhere, each will be considered briefly below.

The Navy supports a substantial part of the Federal research program. Its portion averaged more than a quarter of the total Federal research program in the marine sciences during the period 1968-1970. Only the marine sciences research program of the National Science Foundation was larger and that by only a small amount. When development is added to research, the Navy's share increases to about half of the Federal total (59). Much of the Navy's research has a strong actual or potential relationship to non-defense oceanographic needs. The National Oceanographic Data Center (NODC) helps make available to the non-defense community unclassified oceanographic information spun off from the Navy's defense-oriented research. Until recently, NODC was managed by the Navy but was jointly funded by a number of Federal customer agencies. With the establishment of the National Oceanographic and Atmospheric Agency in October 1970, it was transferred to the U.S. Department of Commerce.

Coastal economic impacts of national defense in this region are most prominent in the Narragansett Bay and Hampton Roads areas. It has been estimated that, of the $340 million in local value added by marine-related activities in Narragansett Bay in 1965, $180 million was attributed to marine military (164).

Some military-owned coastal locations have been released for non-defense purposes in recent years. Examples include Governors Island in New York Harbor and Fort Totten on Long Island Sound. This trend might continue. Historically throughout this region coastal defense installations were developed by the Army along the seaward approaches to major cities to protect these cities from enemy attack. With evolution in the technology of warfare many of these installations lost their original purpose and with it their need for a coastal location. Many evolved into non-coastally related administrative centers. In recent years, a strong trend has developed to make these locations again available for non-military uses. Viewed historically, it may have been fortuitious that the retention of these installations was prolonged until fairly recent years, because it has presented some fresh options to coastal decision-makers that possibly would not have been available had these sites developed in a manner similar to adjacent coastal areas. What is done with these options--preservation, use, development for coastal or non-coastal purposes--is not a national defense problem. Rather, it falls into the broad realm of coastal zone planning and management. Although this possibility of some fresh options is unique these days, it is important that the possibility be kept in perspective.

• First, only a very small part of the NAR's ocean front is currently occupied by the military--say something under one-half of one percent. On the basis of information developed in communication with the National Shoreline Study (136) only about 200 miles of the 4,700 miles of ocean front shorelines in the NAR are Federally owned. All but about 30 of these 200 miles are in four states, Massachusetts with nearly half, Virginia, Maine and Maryland. Within these four states the Federal oceanfront ownership consists almost entirely of non-defense facilities such as Assateague, Cape Cod and Acadia National Seashores, the NASA facility in Wallops Island and several wildlife preserves. Thus, although precise data on military-owned ocean frontage are not available, the total is probably very small, maybe under one-half of one percent. Much of this remainder is for naval and other facilities clearly requiring a coastal location (136).

• Secondly, the decision to abandon a defense coastal facility can have many important implications on the social and economic well-being of the people who are employed by the installation or serve it and its employees. These transitional problems must be given careful consideration; their magnitude in individual cases could conceivably override primarily coastal perspectives.

A substantial portion of the coastal waters in the NAR are to varying degrees reserved for military purposes. However, upon examination, most of these large area restrictions turn out to be very minor, e.g., a large maneuver or gunnery area reserved for defense purposes on rare occasions, say a few days a year.

Like all occupants of the coast, the military is automatically involved to varying degrees with most coastal problems such as those associated with pollution. Because pollution from military reservations is much more closely related to the overall problem of pollution than it is to the military, such problems are integrated into the overall subject of waste disposal rather than broken out for separate treatment under national defense. The same approach applies to the military aspects of other coastal uses and problems. As a result and because purely defense problems are outside the scope of this study, no separate national defense problems were selected for detailed analysis.

Land Use. An increasing number of coastal planners are concluding that the key to coastal planning and management is land use controls. The purpose to which the waterfront is put exerts a dominant influence on the use of the coastal zone especially oceanward of the shoreline.

Acceptance of this conclusion does not necessarily carry with it the license for coastal planners and managers to control coastal land uses. In some places such as the New York Metropolitan area, the urbanity of the situation might quite properly override its "coastalness." Furthermore, it is not necessarily clear in all cases that centralized planning and management ought to override historic, local, market place, and individual mechanisms despite their imperfections.

The above thoughts are not to argue at this point either for or against centralization of land use control. They are intended to illustrate the need to guard against categorical simplifications. The degree to which land use controls are justified and politically realistic can only be decided after a much deeper probe into the overall problem of coastal planning and management probably at the level of an individual state. Because of the all-purpose breadth of viewpoint for this regional study it was decided, with the exception of coastal erosion and flooding, not to treat land use as a separate problem or series of problems. Instead it has been integrated into each use problem and into the overall need for improved planning and management.

GENERAL CONSIDERATIONS

COASTAL PROBLEMS

Anything which interferes with the objective of improving the usefulness of the coastal zone to man, for now and for the future, may be considered a problem.

Problem Types. Two of the most common type problems arise from natural limiting factors and from conflicts between human uses.

Natural limiting factors may or may not be controllable. Examples include seasonality, resource availability and storms.

In conflicts between human uses, the maximum attainment of one use might prevent or greatly diminish the attainment of another use. Even the former case is not ipso facto "undesirable" if the effect is localized and the total gain in human value exceeds the losses in uses foregone or diminished. However, it often happens that the dominant use excludes the other uses to the point where there is a net loss.

To minimize use conflicts their existence must first be perceived. Where the conflict cannot be eliminated, some sort of social tradeoff is necessary based upon indepth knowledge of the interrelationships between all major coastal uses and of the human values attached to these uses.

Actually both types of problems are closely related, and they do not, between them, embrace all possible problems, e.g., problems in ascertaining the real values of peoples. Nevertheless, they do form a handy sieve in broad investigations such as this to increase the likelihood of getting the major difficulties to the foreground.

Problem Locations. As viewed in cross-section perpendicular to the coastline, problems tend to peak on the shoreline itself and the areas immediately adjacent to it. Here are located the spawning and nursery grounds for many species of fish, the most accessible mineral assets, the areas most affected by waste disposal, the beaches, marinas, aesthetic focal points, ports, airfields, coastally-dependent defense installations and a host of residential, commercial and industrial land values, which derive essential or considerable values from their coastal location. Perhaps the most significant of these many problems derive from competing land uses along the coast and from the great sensitivity of living marine resources to the effects of many other uses, especially land fill and waste disposal.

Moving farther out to sea, problems tend to be reduced by the dilution effects of the ocean and its relative inaccessibility. Inland, the coastal aspects of problems tend to fade into decreasing significance, and merge with and become lost in the overall problems of man. Many coastal problems, of course, such as pollution and shoreline erosion, have sources farther inland or seaward, but their coastal impacts are generally concentrated at or near the coastline.

Problems along the length of the coast tend to peak at estuaries. Because they are mostly located at the mouths of rivers, populations tend to peak there. Ports, land values and recreational concentrations are at their greatest there. Inflowing rivers greatly influence the quantity and quality of their waters. These urban related uses, although severe, are a customary part of urban planning, inland as well as coastal. However, unique to the coastal zone is the high weighted value of these same locations to living resources. For the nation as a whole, it has been estimated that about two-thirds of the commercial fish catch is "estuarine dependent." .This means that they spend a significant part of their life cycle in estuaries, whether spawning, nursing or living there or passing through. From a strictly economic point of view, it is hard for the commercial fishing industry, with a total national dockside value of $450 million annually, to stand up against urban demands for "front" land which goes up as high as $3 million an acre in downtown Manhattan.

Problems Selected for Special Analysis. To focus the analysis on a digestible number of major coastal problems in the region, the information acquired during the interviews and literature review was evaluated under the framework. Judgments were made on such things as: the relative severity of various problems, natural limiting factors and interrelations between other water, and related land resource uses both coastal and inland. The base of some problems was broadened to include several previously delineated as individual problems. Other problems were subdivided to provide the increased focus judged to be desirable. Thus "conservation of wetlands" was broken out from "living resources", to which it primarily relates, in order to give wetlands additional specific attention. For similar reasons, pollution was subdivided into three sub-problems--water pollution, thermal effects and solid waste disposal. Upon completion of this broad analysis, a final list emerged. In the later analysis of selected problems, therefore, the appendix will contain an extended consideration of how to improve the usefulness of the coastal zone to man for now and the future in the following nine selected areas:

Living resources
Conservation of wetlands
Non-living resources
Water pollution
Thermal effects
Solid waste disposal
Recreation
Marine transporation
Coastal erosion and tidal flooding

An important influence in selecting these problems was the degree of importance currently being attached to them in each of the 12 coastal states in this region. Based upon information from many sources, especially the 164 interviews, a very general pattern developed for the region as a whole. The importance being attached to these problems could be ranked about in this order. For the region as a whole, the importance being attached to problems could be ranked about in this order:

Major concern: Water pollution and wetlands conservation are being considered as the most important problems. Following a little behind are recreation and marine transporation. If the rating reflected a "man on the street" reaction, as distinguished from the informed opinion evaluated here, marine transportation would drop substantially. So far it is a problem which has not been conveyed to the public.

Significant concern: At midrange on the scale are problems of living resources and of coastal erosion and tidal flooding. If the ranking reflected a "man on the street" reaction, as distinguished from the informed opinion evaluated here, commercial fishing would probably rise and coastal erosion and tidal flooding would probably drop. Memories of losses in great tidal floods of the past are short lived and probability predictions for the future seem unreal. Except for shoreline property owners, the public seems to attach little relationship to their enjoyment of the shoreline and the effort to protect it and them.

Lesser concern: Although there are important local exceptions, for the region as a whole coastal problems associated with thermal dissipation, solid waste disposal, and the extraction of non-living resources are currently being considered as less important than the other six problems. Depending upon results from intensive current research on the effects of thermal and solid waste disposal on marine life, either of these two problems could move far up the perception scale or drop out of sight. The extraction of non-living resources, currently the lowest on the preception scale, could rise significantly if oil and gas are extracted off Maine and if the crisis some predict in the supply of sand and gravel is satisfied offshore.

These gradations must be approached with care. They are not based upon polling, nor have they been referred to the states for reaction. To arrive at them, the impressions of those who did the interviewing and literature search were recorded independently. Where these impressions differed they were discussed jointly and a concensus was reached. Tight definitions and rating systems were avoided as well as sharp distinctions between "major concern," "significant" and "relatively insignificant." Thus the results can be considered only as general impressions. Others, particularly those concentrating on specific aspects of the coastal zone will undoubtedly have different opinions of where the concensus lies. For the region as a whole a large cross section was interviewed, well balanced geographically, functionally, and by institutional levels---Federal, state, private, industrial, academic. The scope of the study, however, did not make it feasible to maintain this balance within each and every state. For example, substantial coverage was given to solid waste in New York and almost none in New Hampshire.

PLANNING AND MANAGEMENT

Although the majority of those interviewed appeared to rank the problems generally in the order just portrayed, the experts themselves almost always generalized their answer at a higher level; they viewed the need to improve coastal planning and management as the number one coastal problem in the NAR. A similar conclusion has apparently been reached at the national level where all currently proposed bills focus principally upon improved planning and management. Thus, the more knowledgeable people become on coastal matters, the more they seem to recognize the large array of uses and interactions which must be considered. Planning and management attempts to provide this consideration.

Need for Planning and Management. Reasons why significant planning and management effort may be required include: (1) the extent of current and predictable demand for coastal use, (2) limitations of the resource base, (3) conflicts between coastal zone uses and between coastal zone and non-coastal zone uses, (4) non-market factors implicit in coastal zone uses, (5) important knowledge gaps, (6) the need for decisions, and (7) organizational patterns of split or multiple responsibility. These problem roots are by no means unique to the coastal zone, but individually and collectively they seem to take on special importance when placed in a coastal context.

Demand. Although the tidewater counties in the NAR contain only a small portion of the region's land, they contain the majority of the region's people. Their proportion of the region's income is probably even higher; nationwide, 40% of the manufacturing plants are in oceanic counties. In the first half of this century, the leisure part of the Nation's time budget has been estimated to have grown about 25% on a per capita basis and about 300% in total (26). An even greater increase is estimated to have occurred in outdoor recreation. Partially because of its proximity to population centers, the coastal part of outdoor recreation has probably grown even faster. Other major uses, especially waste disposal and transportation, have also grown rapidly.

The region's total population and per capita income are projected to double and quadruple respectively by 2020, thus producing an eightfold increase in personal income (Appendix B--Economic Base). The coastal zone should maintain or even increase its present proportion of these increases.

Limitiations on the Resource Base. The physical dimensions of the coastal zone--its shoreline and its seaward and landward areas--are generally fixed. Only limited parts of the zone are suitable for certain uses. Locations suitable for major ports, for example, are generally fixed. As vessel drafts increase, fewer locations will be able to accommodate them. Only about 27% of the region's 8600 miles of shoreline, including bays and estuaries in addition to ocean frontage, are currently suitable for beaches, and public access.

is currently limited to about 17% of the coast (136). The use of the coastal zone for recreation is severely limited by seasonal temperatures with virtually all bathing having to be accommodated in the three summer months. Social factors tend to concentrate this summer use mainly on weekends. The region's acreage of important estuarine biological habitat has diminished physically by about 3% in the last 20 years primarily to accommodate urban and navigation needs (153). Its usefulness for habitat has diminished even further due to changes in water quality.

Conflicts Between Coastal Zone Uses. As might be expected, the heavy growth of demand cited earlier has produced an increasing number of conflicts between alternative uses of the coastal zone. In itself, this is not necessarily bad, as competition often serves to determine the use-priority giving favor to those upon which society places a higher value. However, unless non-market values and external effects are given proper weight, competition can produce solutions which do not adequately represent the best overall, long-range interests of man.

Figure U-4 outlines some of the conflicts which can occur between different uses of the coastal zone. Three preliminary notes are in order:

First, the list is intended to be reasonably comprehensive, but it is not complete. Its purpose is to illustrate the variety of use conflicts coastal planning and management might consider. Detailed development of each conflict is not feasible in this study.

Second, no judgments are intended as to who is the "guilty party" and who is the "victim." Neither prior use, nor economic value, nor non-market values nor any other scheme, is by itself a complete basis for judgment. Thus the prior utilization of an area for fishing (or commercial development) and the environmental characteristics associated with that use do not automatically put it in the preferred position. Uses can and should change as society's values change. To perceive and reflect these changing values is a major role of planning and management.

Third, the word "can" is used in describing each conflict to imply that there are ways of minimizing or neutralizing the conflict or even turning it about to produce a complementary effect. It is beyond the scope of this analysis to present detailed means of doing this, but some illustrative examples are suggested here and in the analysis of other problems. In general, such solutions are brought about by new knowledge and methodology produced by research; and alternatively, by studied tradeoffs based upon an awareness of broad human value systems.

To simplify presentation the numerical entries in Figure U-4 are indexed to the following sub-paragraphs which briefly describe the

SOME COASTAL USE CONFLICTS

Major uses		Resource extraction		Resource return (waste disposal)	Enjoyment		Transportation	National defense	Land use
		Living	Non-living		Recreation	Aesthetic satisfaction			
Resource extraction	Living	1, 2	3, 4, 5, 6, 7, 19	8, 9, 10, 19	11, 12, 13, 14, 15, 16, 19	13	5, 6, 7, 19	17, 19	7, 13, 16, 18, 19
	Non-living				6	6, 20		17	
Resource return (waste disposal)					21	21			22
Enjoyment	Recreation				15, 23	15, 23	6, 25	17	24, 26
	Aesthetic satisfaction						6, 27		24, 26
Transportation								17	30
National defense									28
Land use									26, 29

Notes:

See text for explanation of each conflict. Note that conflicts occur not only between the broad 'Use' catagories shown here, but also within the 'Use' catagory; e.g., between one living resource and another.

Essentially every conflict has land use implications. These implications are considered as part of the conflict itself; e.g., between recreation and transportation. The term 'Land use' denotes uses considered as a whole rather than individually detailed components; e.g., industrial, commercial, or residential land use.

FIGURE U-4

conflicts:

(1) Among its internal conflicts, commercial fishing is affected by overfishing.

(2) Runoff from insecticides, herbicides and agriculture and industrial chemicals can affect fishing.

(3) Oil wells can become hazards to fishing fleets particularly during periods of low visibility. This is especially true if, as some maintain, fish concentrate about the wells.

(4) Extraction of mineral resources such as phosphates, sand and gravel can diminish biological activity in the extraction areas.

(5) Fishing access can be limited in areas used for non-living resource extraction and navigation.

(6) Large oil spills incident to oil extraction and navigation can limit fishing, recreation and aesthetic satisfaction.

(7) Deposition of dredging acquired during non-living resource extraction or navigation improvements or for fill for airports and other land uses can destroy important wetlands. In some places, however, the spoil is being used to provide new wetlands or extend or improve those now in existence (31).

(8) Liquid, thermal, radiological and solid waste disposal can harm or destroy fish or make them inedible; however, in some cases controlled disposal of wastes might benefit fish.

(9) Uncontrolled or artificially-induced changes in sediment loads can affect fish. For example, too much sediment can smother benthic life. In other places it can build up wetlands or provide desirable bottom conditions.

(10) Excess phosphorus and nitrogen, frequently a product of waste disposal, can accelerate natural geological aging processes (eutrophication), with fishing being a prominent victim.

(11) Mass recreation can adversely affect fishing habitats or, in the case of sports fishing, result in overfishing.

(12) Diking off salt water areas to create freshwater reserves for water fowl can destroy salt water fish habitats.

(13) Mosquito control projects employing insecticides can harm or kill fish or render them inedible. Drainage and diking methods can have mixed results.

(14) The construction and operation of marinas in wetlands can affect fish habitat.

(15) Pollution from boats can make shellfish inedible and can limit recreation and aesthetic satisfaction.

(16) Hurricane protection and shoreline erosion works--developed to protect life and recreational and land use values--can produce undesirable ecological changes. However, it is possible in many instances to minimize, eliminate or reverse these ecological side effects.

(17) Temporary, intermittant or permanent restricted defense areas--imposed for reasons of safety, security or militar-operations--can interfere with fishing, non-living resources extraction, recreation and navigation. (Other byproducts of national defense use such as waste disposal from coastal installations and vessels can significantly affect coastal uses. However, these conflicts are coded under the more generic uses such as waste disposal and navigation.)

(18) The sensitivity of fish to environmental change in general can impose significant inhibitions on land use in coastal areas.

(19) Almost all uses can destroy undisturbed areas required as base points for ecological research.

(20) The extraction of non-living resources such as oil, sand and gravel can adversely affect shoreline aesthetics.

(21) Waste disposal can limit recreational use of the coastal zone. If the disposal is significantly intense, it can also affect aesthetic satisfaction to the extent that its presence is perceived.

(22) The more severe forms of pollution, to the extent that they affect other potential uses, can have varying adverse effects on land use.

(23) High density recreation can destroy low density recreation and aesthetic satisfaction.

(24) Private uses of the shoreline, especially residential use, limit public access for recreational and aesthetic purposes.

(25) Pleasure craft can collide with shipping especially during periods of low visibility and heavy traffic.

(26) Industrial and sometimes commercial uses of waterfront property can limit recreational, aesthetic and residential potential in the vicinity.

(27) Piers and adjacent port areas can present aesthetic blemishes especially in locations of high public visibility.

(28) Some defense uses of coastal areas can affect or deny other land use values. Currently, some defense installations which no longer depend upon their coastal locations are locating elsewhere. However, the social and economic impacts of the relocation on coastal localities must be considered.

(29) Urban expansion often requires land which could be used for coastally related uses. An example is wetland filling on the outskirts of New York City.

(30) Port facilities can occupy waterfront of extremely high value for other purposes. An example is in Downtown Manhattan.

Conflicts Between Coastal and Inland Uses. These conflicts can be even more significant than the internal coastal conflicts. As mentioned earlier, perhaps the most significant conflict stems from considerations of the quantity, quality, time distribution and--in the case of diversions--locational aspects of river and stream waters as they enter the coastal zone. The legitimate requirements of coastal users can differ significantly from the legitimate requirements of inland users. For example, fishermen in an estuary will have a different idea of what the quantity and quality of an incoming river's waters should be than people in an inland metropolis which has limited funds for waste treatment and needs to withdraw waters for many purposes. To minimize this problem there is a great need for priority research to define more accurately the requirements of coastal uses, especially fishing, and the incremental effects of deviations from the ideal. Unless this knowledge is gained, major costs in losses incurred or benefits foregone will continue to be felt. The need for knowledgeable remedial actions and tradeoffs is inescapable.

However, even without well defined requirements, the potential interaction between inland and coastal activities must be explicitly included in any planning process. The interactions can be evaluated in terms of:

o Competitiveness--when an activity uses a resource and changes its value for another use; such as waste disposal in a river which in turn pollutes an estuary and diminishes its potential for recreation or fish and wildlife.

- Complementarity--when one use increases the attainment of another use; such as when thermal discharges from power plants are used to improve oyster or lobster fishing.

- Substitutability--when a use can be shifted from one resource to another; such as when the coastal waters are utilized for power cooling in place of inland fresh water.

Using this competitive-complementary-substitutable scheme, some general relationships between the inland and coastal uses of water and related land resources can be suggested. The full significance of these inter-relationships requires rather detailed quantification and the consideration of site-specific conditions beyond the scope of this outline -- and sometimes beyond the current state of the art. As a reminder that these relationships are only suggestive and not detailed, the word "can" will be used frequently to connote "under some conditions." To facilitate compatibility with terminology employed throughout this appendix, the following comments will be cast within the general use-catagorization framework previously adopted for this appendix.

- Extraction of living resources (agriculture, fishing, forestry). If these inland uses introduce significant quantities of pesticides, herbicides, and unwanted or superfluous nutrients into streams and rivers or if they divert significant quantities of water to evapotranspiration and infiltration "losses," they can affect estuarine marine life adversely and thereby be classified as competitive to coastal uses. Activities undertaken inland to improve fish abundance in rivers that feed estuaries are generally complementary to similar efforts in estuaries. Increases in inland protein production, particularly animal protein, can diminish the pressure for the extraction of marine food fish and thereby be classified as substitutable.

- Extraction of non-living resources (mineral and petroleum mining, consumptive use of surface and ground water for a variety of purposes). When these activities pollute waters entering estuaries through acid mine drainage and the introduction of other unwanted chemicals, they can be competitive with the extraction of living resources from estuaries. When sand, gravel, petroleum and other non-living resources are extracted inland, they can reduce pressures on the same resources along the coast and thereby be considered substitutable.

- Waste disposal (liquid, solid, thermal and other wastes). When these wastes are deposited into water bodies which feed estuaries, they can affect a number of coastal uses, especially the extraction of living resources, in a number of ways brought out more fully in the later analyses of water pollution, thermal pollution and solid wastes disposal, and thus be considered competitive. However, when these wastes are transmitted to coastal waters in a controlled way, they can sometimes benefit coastal uses, particularly the extraction of living resources, and thus be considered complementary in special cases. Examples include thermal "enrichment" for fish culture and possibly recreation, and the addition of desirable quantities of "nutrients." When wastes are disposed of on land, the practice can be considered to have a substitutable relationship to coastal disposal. Examples are sanitary fills, cooling ponds, and the disposal of liquid wastes on the land as a nutrient.

- Recreation (water contact sports, boating, sports fishing, hunting and passive pursuits including pleasure driving, viewing, picnicking, and a number of activities generally classifiable as aesthetic appreciation). Few of these inland uses of water and related land resources impact unfavorably upon coastal uses. The main relationship here is one of substitutability: these forms of inland recreation generally reduce recreational pressures on the coast. In some cases, the inland-coastal relationship is a complementary one. Examples are the relationship between coastal waterfowl areas and inland preserves and the movement of pleasure craft between inland and coastal waters.

- Transportation (water, air and land-based). Here inland-coastal relationships are especially complex. For example, when inland waterways are improved for navigation, the activities generally complement marine transporation uses; but the same activities can have a variety of effects on other coastal uses depending primarily upon whether the changes in river regimen adversely or beneficially impact upon marine life and coastal erosion. When airports, roads and railways are located inland instead of along the coast, or when pipelines are used to transport petroleum products in lieu of shipping, the inland-coastal relationship is primarily one of substitutability. Railroad nets are often located to complement marine transportation. An example is the system joining the West Virginia coal fields and the coal handling facilities at Hampton Roads, Virginia.

- Land use (residential, commercial, industrial and defense developments, open space and activities such as flood control and erosion control which are significantly related to land protection and enhancement). An especially important inland-coastal relationship here is substitutability. Estuarine and ocean waterfront is in great demand for a variety of coastal purposes. In coastal land use planning of the future, increasing emphasis will have to be placed upon moving development not functionally related to a coastal location to alternative sites inland. This concept will apply even in individual developments. Thus parking lots and power plants can be located inland and the limited shorelands reserved for uniquely coastal purposes such as bathing beaches and ocean-connected pipelines. Flood control and low flow augmentation activities inland which dampen out extreme high and low flows can affect coastal uses in a variety of beneficial and adverse ways depending upon whether these environmental extremes are judged to have a net advantageous or harmful effect upon coastal marine life, shoaling and sediment-transport, turbidity and shipping. The relationship between river regimen and some coastal uses is developed in further detail later in the discussion of Chesapeake Bay and Susquehanna River.

In summary, it bears repeating that the above outline is entirely illustrative. It is by no means "complete" and every one of the illustrations contain numerous special qualifications beyond the scope of this framework study.

Non-market Factors. As the term implies, these are factors which must be included in any borad assessment of human values, but which cannot be adequately expressed in terms of supply and demand through the economic workings of the marketplace. These non-market factors are very prominent in the coastal zone, but they are by no means exclusive to this zone. They include indivisibilities, externalities and irreversibilities.

An example of an indivisibility is commercial fishing as currently organized. Most of the commercial fishing resources are common property. It would not greatly reward an individual to expand effort to improve or maintain any part of the resource. It must be managed as a whole.

Pollution is a prominent example of an externality, usually a negative one. From the disposer's point of view, little economic reward and considerable expense can be incurred by extensive treatment. Others have to bear the cost through decreased usage of the water resource. There are also external benefits. An innovator, say in coastal mining, may have patent protection but he often does not reap the full value of his innovation.

An example of an irreversibility is the filling of a wetland. It is highly unlikely that a filled wetland will ever revert to its former state of biological productivity.

A primary role of government is to recognize these types of non-market values and see that they are adequately represented in the competition of coastal uses.

Knowledge Gaps. There are many important gaps in our current knowledge of the coastal zone. Probably the most significant is lack of knowledge of the requirements for the living resources of the sea. Can they be made more or less plentiful by potential changes within man's control--or does the present regime, or a past one, happen to be the most ideal? Even if this is known, current knowledge is still inadequate to evaluate the incremental effect of change and the total (market and non-market) costs and benefits associated with these incremental changes. Without such knowledge, society cannot hope to arrive at a fully mature trade-off between landward and seaward demands.

The Need for Decision cannot be escaped. Even the decision to postpone decision is a decision. In the interval until a decision is finally reached, it may be that valuable resources are protected. It may equally be that valuable opportunities are foregone. Perhaps the best formula is: the higher the uncertainty, the irreversibility and the importance of the values connected with the decision, the better the case for a decision to postpone decision. Eventual decision, however, does not have to wait on complete resolution of uncertainty. When priority research can establish upper and lower limits of the competing values, assuming the best and worst of the uncertainties, one set of values can often clearly dominate the other and a reasonable decision can be made.

Elements of Planning and Management. Important aspects of planning and management are deciding what we want (goals), what to do to attain this, and how to put it into action. There are a number of management devices such as land acquisition, zoning, subsidization, permits and other authority delegations. These are, however, not specific to the coastal zone. For the purpose of this report we will concentrate on the organizational considerations necessary to carry out the management functions in the coastal zone.

Organizational Considerations. A number of organizational considerations have been incorporated with related aspects of the previous discussion. This section will provide some general thoughts and summarize organizational aspects first at the state level and then at the Federal, regional and local levels which will probably participate with the state in varying degrees during the state's planning and management of its coastal zone.

Regardless of its level, a coastal planning and management organization might reflect the following considerations:

Integrate landward and seaward perspectives. Enough has been said previously of the need to reconcile the different requirements of these two areas. An authority primarily oriented either landward or seaward may not be in the best position to make balanced judgments.

Maintain a multi-agency character. Since the coastal zone is a geographic concept, one should not be surprised or consider it unsound to see most agencies carrying out their assigned responsibilities there. An authority should be oriented both landward and seaward to be in the best position to make balanced judgments. For example, it might be better to keep outdoor recreation under one agency statewide than to separate out the coastal aspects of outdoor recreation and place them under a coastal zone authority. It would thus seem that some sort of interagency mechanism is required. Such mechanisms are particularly appropriate to comprehensive planning where a breadth of representation is desirable. Interagency solutions are not so quickly produced or as administratively efficient as single agency solutions. However, when important long-range, lasting results are needed on complex matters, the short-term appearance of action can often be sacrificed.

Maintain a strong research capability. Whether it be provided in-house or with contract assistance, the foundation of comprehensive coastal planning and management is knowledge. The planner should have a capability to influence a significant part of the research priorities.

Maintain a balanced approach. A comprehensive treatment of the coastal zone should consider preservation and use and development--not place any one of these above the others--of each major use of the coastal zone. This need to view comprehensive planning simultaneously from a number of different perspectives also augers for an interagency mechanism.

Consider existing mechanisms. It may be desirable to build upon existing mechanisms rather than to reshuffle too deeply for the coastal zone. A new mechanism can produce a very desirable burst of initial enthusiasm, but this often momentary advantage must be weighted against the sustained confusion possible through a proliferation of mechanisms.

The logical focal point for comprehensive planning and management of the coastal zone is at the state level. In keeping with the principle of delegation of authority, this function should be conducted at a level which is broad enough to comprehend most of the significant aspects. Along the coast, the ocean tends to dampen out effects. Thus, water related problems are comparatively much more transmissible along a river from state to state than they are along the coast from state to state. It is easy to think of some exceptions--ocean fishing, interstate estuaries, sand transport in the vicinity of state boundaries, etc.--but in general, the most appropriate coastal span of control is at the state level.

A description of the current coastal organization of the 12 coastal states in this region would be unweildy (54). Furthermore, many states are currently in a state of organizational flux insofar as their coastal zone is concerned.

Within the U.S. Government many organizations have responsibilities which relate significantly to the coastal zone.

The Water Resources Council is the existing focal point for comprehensive, long-range interagency planning for the nation's water and related land resources. It too is composed of most of the coastally active Federal agencies. At regional level, it is involved in many "Type 1" studies, such as the current NAR study, on a joint Federal interagency state basis. Its three river basin commissions in coastal areas include 14 of the Nation's 30 coastal states. One commission is located in the NAR--The New England River Basins Commission (NERBC). NERBC also consists of the Federal agencies and the states. Geographically, the scope of the Water Resources Council's planning authority includes the coastal waters. However, the Council does not have management authority. That authority resides individually in its members and the states who implement the plans.

The Department of the Army, acting through its Corps of Engineers, has broad authority for the planning and construction of navigation, flood control, beach erosion, recreation, and other facilities. It is charged with issuing permits for all offshore facilities on the basis of navigation, fish and wildlife, ecology and public welfare considerations. It leads several major Federal-state comprehensive water and related land resource studies in this region.

The Department of Commerce provides socio-economic projections, navigation services through its Maritime Administration (MARAD) and environmental services through its National Oceanic and Atmospheric Administration (NOAA) which includes groups formerly known as the Environmental Sciences Services Administration and the U.S. Coast and Geodetic Survey. NOAA has also absorbed a number of agencies from other departments including the Bureau of Commercial Fishing, the marine part of the Bureau of Sport Fisheries and Wildlife and the Marine Minerals Technology Center of the Bureau of Mines from the Department of the Interior; the U.S. Lake Survey from the Army Corps of Engineers; the National Oceanographic Data Center and the National Oceanographic Instrumentation Center from the Navy; and the Sea Grant Program from the National Science Foundation. Precisely what NOAA's coastal responsibilities are to be, have not yet been announced, but they may be substantial.

The Department of the Interior, through several of its bureaus, has important coastal responsibilities. Among these bureaus are the U.S. Geological Survey, the National Park Service, the Bureau of Outdoor Recreation, the Bureau of Mines, the Bureau of Land Management, the Office of Saline Water, and the Office of Water Resources Research.

The Department of Transportation focuses on the Nation's overall transportation system which interacts importantly with coastal ports. The Coast Guard is responsible for search and rescue, aids to navigation, law enforcement, and oil pollution control measures.

The recently formed Environmental Protection Agency has absorbed the Federal Water Quality Administration, the National Air Pollution Control Administration, the Bureau of Solid Waste Management and several others. EPA has broad responsibility for integrated management of all aspects of pollution.

The Council on Environmental Quality has substantial overview authority on important environmental issues.

Within this region there are several significant interstate estuaries where interstate planning and management should be considered.

- Narragansett Bay is primarily in Rhode Island, but part of its northeast shorelines includes Massachusetts. The interstate problems of the Bay do not seem to have a magnitude sufficient to require the creation of a new bi-state authority. Apparently coordinated efforts on a less formal basis is proving adequate to the two states. Both states, of course, are part of the NERBC which is managing and coordinating a comprehensive study in the same area.

- In Long Island Sound there is increasing awareness that an interstate approach is required to adequately plan and possibly manage this large densely populated embayment. A study of this area under the leadership of NERBC has been funded and work will start in the near future.

- The Hudson Estuary is one of the most intensively used estuaries in the world. Several existing interstate mechanisms have subdivided between them most of the functions necessary for coastal planning and management. These mechanisms include: The Tri-State Transportation Commission (New York - New Jersey - Connecticut) with general planning authority, the Interstate Sanitation Commission (New York - New Jersey - Connecticut) with responsibility for water and air quality and waste disposal, the Port of New York Authority (New York - New Jersey) with general transportation authority, and the Interstate Palisades Park Commission (New York - New Jersey) with limited authority for recreation and aesthetics. In recent years there has also been talk of a Hudson Compact modeled somewhat after the Delaware Compact. The precise relationship between these authorities and their appropriate role in coordinated coastal zone planning and management is a matter for the affected states to decide.

- In Delaware Bay coastal planning and management is a responsibility of the Delaware River Basin Commission. It is a Federal interstate commission organized under a compact which gives it very broad powers of planning and management. It is currently the only example of its type in the United States, but several more are being considered--Hudson, Susquehanna and Potomac.

- In Chesapeake Bay, one of the largest estuaries in the world, no interstate planning and management mechanism exists. A plan of study has been developed by a Federal interagency state team under the leadership of the Army Corps of Engineers to conduct a long-range comprehensive study of the Bay. About half of the study's proposed $15 million cost is for a large hydraulic model. If the affected states of Maryland and Virginia conclude during, or as a consequence of this study, that a regional mechanism is needed, several organization problems will have to be faced. Unlike the Delaware, which is unified from its headwaters to its estuary, or Long Island Sound which is already under the area jurisdiction of the New England River Basins Commission--Chesapeake Bay might still remain fragmented. It appears clear, for example, that effective planning and management of the Bay must embrace its major tributaries. Two of these major tributaries, the Susquehanna which provides about 50% of its freshwater inflow and the Potomac, are already being seriously considered for a Delaware-type compact. One possible integrating approach, although unprecidented, would be the creation of a Chesapeake River Basin Commission (CRBC) under the Water Resources Council. The CRBC would provide for integrated, Federal-state comprehensive planning for the whole area. Its members would be Federal agencies, all the states in the area and the Potomac and Susquehanna Compact Commissions. All of the members, including the two compacts, would plan together. They would execute (manage) separately, but under the influence of the overall plan they jointly developed. If this approach is not acceptable, two other alternatives are: a Maryland-Virginia mechanism only for the Bay itself with the need to establish cooperative, informal, interrelationships with its tributary compacts; and a continuation of current informal coordination.

At the county level, a major example of a coastal planning study is the current Nassau-Suffolk study. This study is identifying the principal coastal problems, determining what information is needed to resolve them and the state-of-the-art with respect to this needed knowledge. It will then formulate a priority-oriented research and data collection effort and employ the results to construct a management information system. The system will store, analyze and retrieve data, knowledge and decision processes relative to marine needs in bi-county area (20), (42).

Legal aspects. See Appendix S - Legal and Institutional Environment for a definitive treatment of the legal aspects of water and related land resources in the North Atlantic Region. Coastal law has recently been receiving considerable attention, sparked prominently by the Sea Grant program of the National Oceanic and Atmospheric Administration. Two of the many broad classes of issues addressed by this emerging discipline are boundary determinations and the legal aspects of land use management in the coastal zone.

Boundary determinations are especially important along the coast because a number of jurisdictional authorities of international, federal-state, interstate and public-private importance are tied to them. This is particularly pertinent to fishery regulation, mineral extraction, defense use of the seabed, and public versus private rights along the shoreline. Even when jurisdiction is defined in terms such as a three- or twelve- mile limit, difficulties can arise because of some uncertainties as to the location of the baseline from which these limits are to be measured, particularly where offshore islands and embayments present difficult technical problems of interpretation. Some states, Maine for example, feel that they have certain rights far out to sea dating back to their rights when they entered the Union. Even when a baseline is legally established it may change in some circumstances by natural and even man-influenced accretion and erosion. The interface between private and public ownership along the coast is generally tied to some tidal datum -- frequently mean high water -- but it varies somewhat from state to state. Infrequently inundated wetlands often pose special ownership problems.

In land use planning and management along the coast, governments can use a variety of management tools all with important legal implications. The basis for governmental decision-making varies with the part of the coast being considered. In the foreshore -- that part of the shore generally held in trust by the state for the public welfare -- decisions are based on what is judged best for the public good. However, along the backshore -- the land just inland from the foreshore -- decision-making must take into account both the public welfare and the rights of the individual property owners. Since nearly 85% of the backshore in the North Atlantic Region is privately owned, the legal aspects of various land use management tools are particularly important to government coastal planning in this region. Governments can influence the use of coastal lands in four general ways: (1) by agreements such as voluntary acquisition and desirable private agreements; (2) by public policy inducements such as those relating to property taxes, cost sharing, planning maps and protection of private property; (3) by regulatory controls such as zoning, subdivision regulation, building codes, ordinances, permits and orders; and (4) by compulsory taking such as condemnation and inverse condemnation. Each of these tools is discussed in Shore Management Guidelines, a part of the current National Shoreline Study of the U.S. Army Corps of Engineers. Problems of "taking" are currently receiving much attention in the effort to preserve wetlands. Just how far government can legally go to restrict an owner of coastal wetlands in the use of his property is receiving increasing attention by the courts.

"Nature of the Problem. The living resources of the coastal zone can be considered from a number of points of view. Among these are:

° Recreational. Many consider utilization of coastal living resources for recreation to have a human value equal to or greater than the other two aspects listed below. In states such as New Jersey, the catch of the recreational fishery is highly significant and so is the value of this activity in those areas that cater to it. (See discussion of recreation, page 116.)

° Relationship to other uses. Living resources have a relationship to almost all other major uses of the coastal zone. These relationships may be viewed either as detriments or assets. In Chesapeake Bay, the presence of the stinging sea nettle is considered a severe drawback by recreationists and fishermen. Also in this area, as well as in Long Island Sound, the presence of dense weed beds of species such as Eurasian milfoil and eelgrass are classified as "nuisances" by boaters. However, the value of these latter biota as wildfowl habitat is also recognized.

° Commercial exploitation. This point of view is chosen as the focus of the discussion in this section of the report."

Currently, the commercial exploitation of the living resources of the coastal zone centers on fishing and the harvesting of both wild and cultivated stocks of shellfish. Other activities, which are carried on to a lesser extent, concern the harvesting of marine worms (Maine) and seaweed[1/] (Maine and Massachusetts).

Indications are that the future could see not only a greater return from these various harvesting activities, but also the development of new methods of exploitation. In general, the United States fishing effort is aimed largely at those species readily marketable to the American consumer. However, it should be noted that some other countries have found it profitable to harvest species not otherwise desirable for use in fish meal preparation. These include the undertaking of various forms of mariculture, as well as the development of new products from the sea, i.e., drugs. However, since the finfish and shellfish of the coastal areas will continue to be the main focus of attention, the following discussion is undertaken with these species in mind.

1/ Irish Moss, a seaweed found off the northern coast of North America, is the source of carragreen, a gel used in a wide variety of products. Its harvesting is currently low, but its potential is estimated at $15 million annually. (76)

Accordingly, the problem to be dealt with herein is defined as "how to increase the yield of the living resources of the coastal zone to advance the goals of increased food supply and local economic development," This problem definition is based on the assumption that the existence of a viable industry of this type is a regional goal. The following discussion concerns commercial fishing as an industry in terms of the definition of the problem given above. For further discussion of this industry, see Appendix O - Fish and Wildlife.

The rapidly expanding world population has a great need for new sources of animal protein, and many people are looking to the sea as an important source. This drive is reflected in the increasing effort devoted to the harvesting of fish in recent years. Between 1948 and 1968 the world harvest tripled from 18 million to 64 million short tons. (19) The domestic U.S. market for these products has also experienced a fairly steady increase with a record consumption at 8.7 million tons in 1968. (156) A projection in that year showed a continually growing domestic market reaching some 15 million tons by the year 2000. (60)

In contrast to this rising demand, the fishing industry in the United States has remained fairly static. The United States has dropped from second to sixth place among the major fishing countries of the world since 1956. In 1968, it harvested only 3.8% of the world catch. (60) In the 1959-1969 period, the domestic catch varied between 2.0 and 2.7 million tons. The difference in domestic market and supply has been filled with an increasing number of imports which in 1968, a record year, totaled 6.6 million tons. (156) Yet, it has been estimated that the known resources adjacent to the United States coast are capable of yielding 22 million tons per year on a sustained basis. (19) These resources are currently being exploited to a great extent by other countries.

This inability of the fishing industry to expand to meet a growing demand in face of, at least in certain areas, extensive resources constitutes the nature of the problem. This phenomenon is even more pronounced in the North Atlantic Region than it is on the national level.

Major Causes. The causes of this problem can be classified into three major categories--institutional constraints, knowledge gaps, and environmental conditions.

Examples of institutional constraints:

- The sum of the sections of Title 46 of the United States Code virtually require American fishermen to use vessels built in American shipyards. This prevents them from taking advantage of less expensive vessels of more advanced design built overseas.

• The costs of liability insurance are extremely high. In part, this is a result of the Jones Act which states that an owner is liable even if seaman negligence is involved in an accident. These high costs cut deeply into profits.

• In both shell and fin fisheries, regulations on fishing techniques have been established to protect the stock from overfishing. However, these regulations have instead tended merely to decrease efficiency causing more fishing effort per unit catch and thereby serving to further depress the economic position of harvestors. This has been true for many fisheries off the New England coast as well as the oyster industry in Maryland.

• Although there are many international agreements regulating the catch techniques in offshore waters, no mechanisms exist to enforce these agreements. This results in overfishing to the point where valued stocks are endangered.

Examples of knowledge gaps:

• Lack of knowledge concerning the extent and recruitment rate of most species caught by the industry in the North Atlantic Region results in an inability to gauge the level of sustained yield. This is evidenced by estimates of potential sustained increase widely ranging between one and tenfold. If the latter estimate is correct, a serious underutilization of valued species exists.

• Not enough information is available on the life cycle of most species and their sensitivity to environmental changes and man-made influences such as pesticides. This makes the effective management and protection of these living resources impossible.

• Of the body of knowledge that is currently available, little finds its way into practical use at the harvesting level.

Examples of environmental conditions:

• The destruction of wetland areas has reduced the required habitat of many valuable species, i.e., menhaden striped bass. This subject is considered in more depth in the next special problem, conservation of wetlands.

• The pollution of coastal waters has had a severe impact on the commercial shellfish industry. Even when these species have survived, their harvesting is limited by health considerations. This is true of both clams and oysters in several areas of the North Atlantic Region.

The combination of these many factors has resulted in an inefficient, fragmented industry unattractive to new employees and incapable of expanding to take advantage of a growing market.

Location. This problem is found in all parts of the North Atlantic Region, since every state engages in some form of fishing activity. (Table U-2) Particularly affected are the offshore finfishing activities in Massachusetts, where the volume landed decreased by over 30% between 1966 and 1969. The industry in Virginia has also experienced a severe reduction. The effects of pollution on the shellfish resources have also been universal in the NAR, with the most severe occurrences near the heavily populated areas.

Time Characteristics. Internationally the commercial fish catch has been increasing much faster than population over the last several decades. Despite this evidence of what is possible and the expanding domestic demand, the commercial fishing industry in this region has not yet demonstrated an ability to become economically viable.

Parties Affected. Beyond the consumer, the individuals most affected by this problem are those involved in the direct harvesting and processing of finfish and shellfish. It is characteristic

TABLE U - 2

COMMERCIAL FISH CATCH BY STATES

State	Volume in Thousand Short Tons				Value in Million $			
	1966	1967	1968	1969	1966	1967	1968	1969
Maine	100	99	109	96	24.3	23.0	25.6	27.5
New Hampshire	1	1	1	1	.7	.7	.8	.9
Massachusetts	205	173	169	140	46.2	39.1	41.6	41.9
Connecticut	2	2	3	2	1.8	1.8	1.8	1.8
Rhode Island	34	38	35	41	5.3	5.7	6.0	5.2
New York*	32	19	30	20	11.5	12.7	14.4	13.6
New Jersey	49	62	62	46	9.9	10.7	10.2	10.9
Delaware	3	0	0	0	.3	.3	.3	.2
Maryland	42	37	27	36	14.3	17.4	15.3	17.9
Virginia	209	174	194	139	21.0	18.1	20.6	17.8
Total	677	605	630	521	135.3	129.5	136.6	137.7

*These figures include a small contribution by inland fisheries.

SOURCES: Adapted and rounded from (155), (156), (157) of the fragmentation found in this industry that, although the producer level has remained static, the processing and retailing levels have thrived as imports have increased.

Solutions. A three-pronged attack on this problem would include a basic change in philosophy regarding the exploitation of these living resources, new technological and biological research, and an attack on the environmental degradation which limits the full development of productive species.

The first step in an industry revitalization should center around a basic philosophy change toward the principle of limited entry. The current view of the living resources of the coastal zone as a common possession to be harvested at will has led to a "if I don't take it someone else will" attitude which, although understandable, does not beget an optimum utilization of the resources involved. The result is an increased strain on the valued stock and, as more harvestors become involved, a general lowering of the profit. Less and less becomes divided among more and more.

The limited entry principle is seen as a potentially effective way of combating this problem. This evaluation is in part based on the experience of Virginia and Maryland as regards their shellfish resources. The initiation in Virginia of a limited entrv philosophy to part of its oyster industry has resulted in higher yields and greater per capita income for harvestors than those in Maryland where stock protection is undertaken through limitations on harvesting efficiency.

"An international interpretation of the limited entry principle would be the extension of the territorial waters of the United States as much as several hundred miles as some South American countries have done."

Another factor in the solution of this problem involves the current restrictions on boat purchase, which should be critically evaluated. The present regulations function as a subsidization of the ship building industry which, although perhaps necessary at the time of enactment, has become superfluous. More disbenefit accrues to the fishing industry than benefit to the shipbuilders.

More research is needed to provide a greater understanding of the life cycles of valued species with a view toward better management. Combined with this must come a recognition of the cross jurisdictional management needs required for effective control of migrating species. An effective agency with enforcement powers will be needed to implement the cross jurisdictional activities needed to manage migrating stock.

Research must also be directed toward uncovering new methods of increasing fishery yields. This should be both in terms of new harvesting methods of natural stocks as well as the intensive cultivation of certain species.

The impact of environmental degradation on the industry must be minimized, primarily by wetland conservation and pollution control. The loss of wetlands should be arrested and the wetlands should be managed to improve their natural contributions to fish abundance. Aspects of pollution control particularly beneficial to commercial fishing are (1) the control of human fecal wastes in shellfish areas, (2) the control of toxic materials such as mercury, and (3) the controlled application of "pollutants" for nutrients and habitat improvement. Examples of the latter aspect are the creation of artificial reefs through selective disposal of solid wastes and the inducement of artificial upwellings at points of thermal discharge. Barring unexpected major breakthroughs in pollution abatement techniques, the yield of edible shellfish can probably be increased much more rapidly and effectively by purification methods than by reducing pollution enough to meet the very high standards of water quality required for shellfish harvest.

CONSERVATION OF WETLANDS

Nature of the Problem. The problem to be dealt with in this discussion concerns the destruction of the coastal wetlands of the North Atlantic Region and how and to what extent they can be conserved.

The term "wetlands" has been subject to many definitions, both broad and narrow, by the political structures, private agencies, and researchers concerned with their existence. For this discussion, a delination was chosen which is patterned after that used by the U.S. Bureau of Sport Fisheries and Wildlife in their surveys. This delineation includes the marshes bordering tidal lands and the intertidal region.

The preservation of wetland areas in their pristine state is the goal of many preservationists. However, in many areas, the pressure of other activities does not allow for the complete setting-aside of areas to be untouched by man. Also throughout most of the NAR it would be difficult to find lands as yet unmodified. For these reasons the term "conservation" is used to reflect the broader goal of maintaining these wetlands in some degree of functional integrity. In this framework, the preservation of wetlands becomes one of the alternatives of their conservation.

The nature of the wetland problem can be explained in terms of the natural function of wetlands and their desirability as a site for other of man's activities. Superficially, this conflict seems to be the standardd one of economics versus aesthetics and conservation. However, a closer look at the natural function of these areas also brings to light many secondary economic considerations of considerable magnitude.

There are five basic functions of wetlands in their natural state.

° Nutrient recycling. Organic matter contained in the runoff from upland areas and that brought in as part of tidal surges is broken down by the microbial population of the wetlands or used as food by higher life forms. Thus is formed the basis of a complex food web, many portions of which are harvestable for the benefit of man.

° Nursery area. The nutrient rich waters of coastal wetlands provide the background for a rapid rate of photosynthetic activity. In addition, the shallow waters of these areas allow for rapid warming by the sun. This combination of a plentiful food supply and moderate temperatures provides an environment conducive to the survival and rapid growth of the fry of species important to the food supply of man.

• Wildlife habitat. The biota rich waters of the wetlands attract many species of waterfowl and mammals which are a source of economic benefit and recreational satisfaction to man.

• Flood plain function. When they are inundated, wetlands absorb large volumes of water (valley storage in flood plain terminology) and thereby help mitigate the potential damage of floods. Wetlands, with their boglike substrate and dense grasses, can also serve in a limited way as a buffer in absorbing the force of storm tides and waves. This is discussed later under coastal erosion and tidal flooding.

• Erosion control. The same physical characteristics which serve to protect upland areas also serve to prevent the filling in of adjacent waters by silt running off from these land areas. The removal of this mode of natural sediment control results in more dredging of adjacent waterways to maintain their navigability.

The relationships between wetlands and fish abundance needs better quantification. Two often-used gross indicators are (1) annual production of vegetation in tons dry weight per acre and (2) the estuarine-relationship of the commercial fish catch. Under the first approach it appears that total productivity decreases markedly northward because of shorter growing seasons. For example, the annual production of smooth cordgrass in tons dry weight per acre has been reported as between 4.4 and 10 tons in Georgia, 2.9 in North Carolina, 2.2 in Virginia, 2.0 in Delaware and 1.3 in New Jersey (161). Under the second approach, Table U-3 depicts the part of the commercial fish catch represented by "estuarine-related" species, those species which spend any significant part of their life cycles in or passing through estuaries. Although not all estuarine-related species are necessarily dependent upon wetlends, the information in Table U-3 does provide a general first order approximation better than any broad index now in use. Using Maine for illustration, it appears that something under 19% of its commercial fish catch is significantly and directly related to Maine's wetlands.

Because of their location at the land-sea interface, wetlands are seen as ideal sites for many activities which jeopardize, to a greater or lesser extent, these natural functions. For many of these activities, a location at this juncture of land and water is a necessity, i.e. port facilities. However, for the majority of activities being located on wetland areas may be desirable or economically beneficial, but it is not essential. The use of wetland areas for solid waste disposal, dredging spoil disposal, residential development and most industrial developments fall into the latter category.

Major Causes. The traditional view of wetlands as "wasteland" to be "improved" has been a basic cause of the destruction of many

TABLE U-3

ESTUARINE-RELATED FISH CATCH

--In $million dockside value of 1968 commercial fish catch--

	Me	N.H.	Mass.	R.I.	Conn	N.Y.	N.J.	Del	Md.	Va.	Total NAR
Finfish:											
Estuarine-related	.2	-	9.5	1.9	.2	2.4	2.9	-	1.7	6.5	25.4
Total	5.6	-	25.6	2.8	.3	3.0	3.4	-	1.7	6.6	49.0
% estuarine-related	3	-	37	68	71	81	87	100	100	99	51.7
Shellfish, etc:											
Estuarine-related	4.7	-	3.0	.8	.4	8.3	5.7	-	14.3	11.6	49.0
Total	20.0	.6	16.0	3.5	1.2	11.4	7.3	.2	14.3	14.0	88.4
% estuarine-related	23	3	19	2	31	75	78	100	100	83	55.4
Total:											
Estuarine-related	4.8	-	12.5	2.7	.6	10.7	8.6	.2	16.0	18.2	74.4
Total	25.6	.7	41.6	6.3	1.5	14.3	7.3	.2	16.0	20.6	134.1
% estuarine-related	19	3	30	43	40	74	85	95	100	88	54.2

Minor differences in subtotals and percentages due to rounding.

SOURCE: Data computed from (156). List of estuarine-related species from (170).

of these areas. Lacking in the spectacular beauty of a mountain peak or a waterfall, they have seldom been prized for themselves. A lack of understanding of the important natural functions which they serve has also contributed to this misconception. Even when these attributes become apparent, the inability to put a dollar value on them becomes a stumbling block in combating the economic pressures for wetland modification.

This phenomenon is particularly apparent at the municipal level. Present patterns of land ownership and zoning prerogatives leave the management of a major portion of wetland areas in the hands of these local governments. These agencies are constantly faced with the necessity of increasing their tax base in order to supply the costly services demanded by their citizens. The destruction of wetlands by filling to make room for new industry or better housing is an often chosen path for satisfying this need.

Other demands of local residents are also satisfied through the modification of wetlands. For reasons of both health and comfort, extensive dredging is often undertaken in wetland areas in an attempt to eliminate the shallow water breeding areas of mosquitoes. This is often done in conjunction with the extensive application of pesticides which also destroy other biota of the area. In addition, wetlands have been used extensively as dumps for the wastes generated by urban areas. This not only results in the destruction of the wetlands but has serious impacts on offshore areas.

Near major ports, such as New York and Norfolk, large areas of wetlands have been lost through the dredging and associated spoil deposition associated with navigation improvements. Such major urban areas also indirectly impact on wetland areas via their general water pollution problems and the resultant effect on the biological productivity of these areas.

Thus, the destruction or modification of wetlands has been occasioned by a lack of understanding, the economic pressure exerted by both requisite and non-requisite activities, and the short-range planning of local governments.

Location. The destruction and deterioration of wetland areas and related shoal water and shell habitat, has emerged as one of the major coastal problems of the North Atlantic Region. Although criteria for definition of wetland areas are not uniform and data from different sources vary, Table U-4, adapted from the work by Spinner (115), serves to indicate the location and, in part, the severity of the problem. The states having the greatest percent loss of wetland areas are New York, Connecticut, and New Jersey. Within these states, the problem is particularly acute near the major population centers.

TABLE U-4

EXTENT OF COASTAL WETLANDS IN THE NORTH ATLANTIC REGION

STATE	COASTAL WETLANDS TOTALS - 1954	ESTIMATED ACRES DESTROYED 1954-1968	PERCENT LOSS
Me.	29,182	300	1.0
N.H.	6,060	150	2.5
Mass.	45,895	1,200	2.6
R.I.	2,200	150	6.8
Conn.	14,744	3,200	21.7
N.Y.	45,395	13,000	28.6
N.J.	241,060	25,300	10.5
Del.	114,048	4,600	4.0
Md.	204,060	20,200	9.9
Va.	210,250	13,000	6.2
Totals	912,894	81,100	9.4

The acreage of wetland enumerated in Table U-4 only partially reflects the severity of this problem. A comprehensive picture must include some measure of the extent of wetland deterioration in terms of reduced productivity or loss of functional integrity. Although this information is not currently available, in many areas the amount of wetlands thus affected is felt to be considerable.

Time Characteristics. The current popular recognition of this problem has served to retard, to some degree, the destruction of these areas. Most states have, within the past three years, either enacted legislation to prevent the filling and dredging of wetland areas or reinforced legislation already on the books. However, the deterioration of many of these areas through the impact of other activities associated with urban expansion, such as water pollution created by waste disposal, is accelerating as population concentrations increase.

Parties Affected. Many individuals are affected both directly and indirectly by the destruction of these wetland areas. As implied above, net economic benefits usually accrue to municipalities bordering these areas as well as to the industries and commercial activities which are sited on these filled areas. Although these benefits tend to filter throughout the municipalities, some segments of the community will experience an economic set-back, such as those engaging in commercial shell and finfishing activities.

The destruction of wetland areas also impacts on many recreational activities which depend in some measure on their existence. Among these are hunting, fishing, and passive activities such as hiking and bird watching.

Sollutions. Two mechanisms exist for the conservation of wetland areas - acquisition and legislation.

The acquisition of wetland areas by both public and private agencies for the purpose of preservation has accelerated in recent years. All the states in the North Atlantic Region have active programs for wetland acquisition. Most of these are based on voluntary purchase, but two states also possess the authority to acquire land by eminent domain, e.g., Massachusetts and Connecticut. This acquisition of wetland areas for preservation or limited recreational activity is certainly the most effective way of combating the problem of wetland destruction. However, the constraints of a lack of sufficient funding combined with an increase in the price of these areas has proved to be a stumbling block in attaining the land desired.

A potential solution to this difficulty could be found in a system of cost sharing with the federal government as part of, perhaps, a National Estuary System. This dual level cooperation has already been applied to the acquisition of wetlands in New York (75/25 State-County sharing) with some measure of success (50). No generally applicable figure can be developed for the cost of such an undertaking since price is so dependent on local conditions.

Public acquisition through the dedication of privately owned wetlands to public agencies has occurred and should be encouraged. This might be done through the development of better tax reduction incentives. Similar favors could be granted to individuals giving land to private agencies for the sole purpose of preservation.

Legislative controls geared toward the conservation of wetlands relate primarily to dredging and filling activities. At the federal level, this power is administered by the Corps of Engineers. At the state level, this authority resides in a variety of agencies, and some states do not possess such controls. This latter level is one at which a great deal more effort is required to obtain stronger legislation with a view to area planning. In addition, legislation should be developed to restrict wetland deteriorating activities on valuable areas which cannot be acquired. Such measures have been established in Massachusetts, and have thus far been used for the protection of over 12,000 acres of wetland. This legislation has established limited case precedents in recent litigations and may well become an inexpensive method of protecting these areas. In fact, due to the funding problems encountered by the acquisition programs, restrictions upon wetland activities are likely to be more instrumental in upgrading the general quality of the wetland areas of the North Atlantic Region.

Lastly, it must be noted that wetlands do not exist in a vacuum and often suffer deterioration from the indirect impact of other activities, i.e., via water pollution due to upstream activities. Thus a part of the solution to the wetland problem must be in terms of a reduction of other environmental problems.

NON-LIVING RESOURCES

Nationally, the extraction and utilization of non-living resources has one of the highest growth rates of the many uses of the coastal zone. In the North Atlantic Region this exploitation and its associated problems are currently limited both in magnitude and locale. The probability exists, however, that both will significantly increase in the near future. This increase will be associated with the intensification of current extractive activities, as well as the utilization of yet untapped resources such as oil and gas. The probable impact of these activities upon the economy of the coastal area, as well as the quality and use of its land and waters, warrents its inclusion in this appendix.

Some freedom of structure was taken in the writing of the following discussion. After a brief section on the nature of the problem, each of the major sections concerns itself with a selected category of non-living resources -- (sand and gravel, oil and gas, metals, and water). Within each of these sections, the problem dimensions delineated in the table of contents are generally followed.

Nature of the Problem. In the not very distant past, the extraction of non-living coastal resources was considered a problem only in terms of the technology of extraction and the economics of recovery and processing. Although some conflicts with other uses of land area might occur, the value of the extracted product was usually the overriding argument in any decision made in an industrially-oriented and rapidly expanding economy. The damage done to other activities and resources was merely part of the price paid.

Although the above philosophy is still in limited existence, in recent years the picture has changed. The incompatibility of most extractive operations with other uses of an area has led to a consideration of the value foregone in choosing resource exploitation. Conservationists have expressed concern over the impact of these extractive activities upon the biota of an area and the extent to which these effects were unavoidable. Private individuals have begun to vocalize their discontent as these exploitive operations offend their eyes, ears, nose, and general aesthetic sense. Yet, all of these changes have taken place against a background of increasing demands for the products of this exploitation.

Within this framework of opposing values, two questions must be considered both in terms of the goals of the NAR study and in terms of the goals of the various political subdivisions involved:

- Should exploitation take place? This may not be an absolute question but only one relative to time and place.

- If exploitation takes place, how can it be controlled for the protection of the other legitimate activities in this area and still maintain its viability?

Involved in answering these questions are considerations of the quality and quantity of the resource, the cost of recovery, the regional and national "need", the availability of alternative resources, the impact of the exploitation upon other activities in the area, and the economic and social value of these activities. These questions and considerations constitute the basic "problem" of non-living resource extraction in the coastal zone.

Sand and Gravel. Currently the mining of sand and gravel from onshore and offshore sites is the major mineral extractive activity in the coastal zone of the North Atlantic Region. Associated problems are economic and environmental.

A significant part of the cost of this aggregate is its transportation. To minimize this cost, either supply must be located near demand or very inexpensive large bulk movements must be feasible. Demand peaks locally near developing urban areas with extensive highway and building programs, and along beaches which are periodically replenished with sand. For supplying urban needs nearby onshore sites are frequently exhausted, built over or closed for environmental reasons discussed later. The National Sand and Gravel Association predicts a generally critical supply situation near most urban areas within the decade. The farther the source from demand the greater the need for very inexpensive bulk transportation. These factors combined with findings of large quantities of sand and, occasionally, gravel in coastal waters have made the following two alternatives, both of coastal significance, increasingly attractive:

- For urban areas: dredging to barges and barge movement to demand centers. Sand and gravel movements are already second only to petroleum products in annual tonnage for most of the small ports near urban centers, such as those along Long Island Sound and Chesapeake Bay.

- For beach renourishment: dredging and pumping directly onto beaches from either the backbay or ocean site.

The extractive activity can impact adversely on the environment. Onshore sites can present a bleak picture of dust covered buildings and wasteland-like stretches. Improper slope maintenance can cause erosion of surrounding lands, and washing of the extracts can deposit silt into surrounding waterways. Abandoned excavation sites can become stagnant pools or open dumps. Trucking the material from its source can be noisy, dusty and hard on local roads. These conditions have led many municipalities to restrict onshore extraction severely or prohibit it completely.

Offshore, material can be dredged from the shallow backbays or from deeper open waters farther offshore. Environmental effects in the latter areas do not appear to be major although continuing study is required especially of before and after conditions.

If not sited and executed with care, dredging in shallow backbay areas can cause major environmental damage. It is possible for such dredging to alter water currents and thereby trigger subsequent changes in local erosion-accretion patterns. If deep holes are left in the wake of extractive activity, the holes will tend to concentrate the normal bottom detritus found in the vicinity. A lack of water circulation in these areas results in anaerobic decomposition of this material with the production of hydrogen sulfide. These areas can thus become inimical habitats for most life forms. Silt suspended during the dredging process increases the turbidity of surrounding waters and thus reduces photosynthetic activity. As the silt slowly settles out, it covers adjacent areas and becomes a substrate which may not be conducive to rapid recolonization by benthic life. In the worst locations, where the bottom is actually removed or covered with spoil, it has been reported that it frequently takes a year or two for benthic life to reestablish itself. (111)

Many activities in the coastal zone are affected by the extraction of sand and gravel, both positively and negatively. Foremost among the beneficiaries of an extensive supply of aggregate is the construction industry which seeks to serve the demands for facilities by a diversity of interests. Via this route, all residents of the coastal zone are affected.

Recreational interests benefit in certain areas, like New Jersey, from use of sand dredged by the U.S. Army Corps of Engineers in their beach replenishment activities. Navigation and port development activities are aided by such extraction as part of channel dredging projects.

Many of the diverse interests which can benefit from a cheap and ready source of sand and gravel can also be adversely affected if the environmental abuses cited earlier are allowed. Adjacent land values can be lowered by the aesthetic impacts, shellfish areas can be harmed, and the attractiveness of the sites for finfish can be substantially diminished.

There is little probability of developing economical substitutes for construction and beach sand and gravel. Therefore solution devices developed for these problems must be oriented toward mitigating environmental effects.

In the on-shore excavation, more foresight is needed in planning for the utilization of the land when mining is completed. The constantly rising value of land near urban areas should permit a significant amount of expenditure for land rehabilitation without the fear of long-range financial loss to the private investor. An alternative plan might call for the purchase by the municipality of areas suitable for land and gravel extraction. Such areas could then be leased for mining activities and later rehabilitated for public use. (88) This planned reuse of mined-out areas will add new values to area communities and eliminate the "lost land" argument which often now bars exploitation in promising on-shore sites. For examples on Long Island, see the later discussion of Area 13.

Some thought should also be given to the impact of the mining activity while it is in operation. Physical structures can be camouflaged to improve their aesthetic impact. Settling ponds or some screening mechanism could be developed to eliminate the silt deposited in nearby waterways. As extraction in specific areas is completed, rehabilitation of the land should be undertaken immediately so that undesirable uses are not allowed to take hold.

As the technology advances, dredging for sand and gravel will be able to take place farther offshore. This further removal of the activity will help to mitigate the impact on other area uses such as shellfishing. Regardless of depth, however, more care will need to be exercised with regard to the bottom topography. Dredging permits should specify in detail the degree of leveling required or the network to be dredged to eliminate the development of isolated pits. In addition, more enforcement will be needed to ensure compliance with the specifications of the permit. Such care may result in an indirect beneficial effect to sportfishermen in areas where dredging activities result in deep interconnecting trenches. These areas, when properly constructed to maintain circulation, provide wintering habitats for valued sport fish. Also, as on land, some innovative techniques need to be developed to combat the dispersal of silt and its consequent deleterious effects.

Considerable additional treatment of dredging and sand and gravel may be found later under the special problems of marine transportation and of coastal erosion and tidal flooding.

Oil and Gas. The national demand for oil and gas is constantly increasing. To meet this demand and to safeguard our economy against a slowdown in oil imports, new reserves need to be constantly searched out and proven. Increasingly, companies have turned to offshore areas for these supplies. In this move, they have been faced with public concern regarding the impact of the drilling activity on the living resources of the area, as well as a fear that the extractive activity and the movement of the petroleum to refineries will markedly increase the likelihood of a major oil spill and its consequent damage to fish, wildlife, and shoreline property. This conflict has become a severe problem.

One area which has become the center of this conflict is Georges Bank, off the northeast coast. This region is considered to have a good potential for oil and gas supplies; however, Georges Bank is also the site of one of the richest fisheries along the North American coast. It is currently being fished by many countries in addition to the United States, and the possible effect of the extractive activities on this living resource is unknown.

The impact of the offshore exploitation of oil and gas on shoreline areas would likely be mixed. Benefits could potentially be derived from an increase in economic activity resulting from a need to provide supportive functions in terms of harbors, storage areas, and processing plants for a variety of petroleum-derived products. However, adverse effects would also be likely from the increased threat of oil pollution mentioned above, as well as the environmental degradation resulting from these increased commercial activities.

One solution that has been proposed to this dilemma is that exploitation be deferred indefinitely, and the area be maintained in escrow until the need for new supplies becomes critical enough to require its exploitation. This alternative deserves serious consideration. From the standpoint of environmental quality, the declaration of this area as a reserve supply would be a completely effective way of avoiding any environmental problems. In view of the comments contained in the President's Panel on Oil Spill's 1969 report, (92) this solution might also be a beneficial measure in terms of the national interest.

If exploitation is chosen, a major effort will need to be undertaken to delve into the extent of impact on the fisheries and possible ways of mitigating any deletorious effects. Although the situation is quite different, much information could be obtained from investigations involving the biota in areas in the Gulf and off the West Coast where oil has already been recovered for a considerable period. Efforts will also have to be made to combat the threat of oil pollution. In terms of the possibility of a vessel oil spill, new techniques will need to be developed to enable the containment and recovery of oil in the rough northern waters. The technology is already well advanced in terms of safeguarding against the possibility of a blow out. However, stringent regulations will be needed to require the application of this advanced know-how, and inspection and penalty enforcement will be needed to insure compliance.

Since the extent of offshore oil and gas deposits and the impacts of their exploitation on other activities is largely unknown, no firm dollar value can be quoted in discussing costs of problem solutions. One can only speak in relative terms.

Involved in the immediate exploitation of these fields are the value associated with the product, the potential income to onshore areas from new supportive activities, the potential loss to the fishing industry, and the certainty of some degree of environmental degradation.

In the short term, the costs of putting these offshore resources in escrow is reflected in the value foregone in terms of cost of leases. product value, onshore development potential and the economy of all individuals and industries which use petroleum products. It is also reflected in continued fishery value and in the avoidance of environmental degradation. In the long term, the probability exists that the increasing price per barrel of this non-renewable resource will serve to increase the value of these deposits. In addition, improvements in technology are likely to reduce the costs of recovery and the occasions of environmental damage.

Substantial additional treatment of oil pollution may be found later under analysis of the special problems of water pollution and marine transporation.

Metals. Currently, the exploitation of metals in the coastal zone of the North Atlantic Region is restricted to the mining of zinc and copper on the coast of Maine and the extraction of magnesium along the coast of New Jersey. Maine is also rich in other heavy minerals both onshore and under coastal waters, i.e. molybdenum in Penobscot Bay. However, no plans exist to extract these resources in the near future because of both their marginal value and the impact of mining activities on environmental quality.

Low grade deposits of beryllium are found in the waters off New England. Other submerged areas of the North Atlantic region contain traces of zircorium, titanium, and thorium. However, because of their low-grade and the cost of recovery, none of these metals are thought to be a source of mining activity in the foreseeable future.

As technology rapidly advances, a potential does exist for the recovery of manganese and phosphate nodules in deep areas off the Atlantic coast. The impact of this activity on the coastal zone will be through the development of onshore unloading and processing sites. With the development of these primary supportive sites will come a myriad of secondary economic activities and the consequent impact on the quality of the shoreline areas.

Solution mining or the extraction of minerals from sea water as used for magnesium extraction in New Jersey is technologically feasible. Currently this process is being used in other areas for the recovery of bromine and salt as well as magnesium. These recovery operations resulted in a total value of $630 million between 1960 and 1966. (39). Future activity will most likely be part of a larger complex which would include a nuclear generating station and desalinization plant.

Water. There are three major current and potential uses for the water of the coastal zone. These are the utilization of underground water supplies for consumptive purposes, the potential desalinization of saline water for this use, and the uses of the brackish and saline waters of the area for power plant cooling.

At the present time, coastal areas such as Long Island and

Cape Cod depend for a major part of their water supply on underground deposits. Maine, New Hampshire, Massachusetts, and Rhode Island have only limited supplies of this resource, mostly in glacial deposits. The southern part of the North Atlantic Region contains extensive coastal plain formations but, especially in Delaware and Maryland, these are mostly brackish. In New Jersey, although salt water intrusion may be a problem, consideration is being given to making extensive use of these coastal aquifers for water supply. "Research is needed on the effect of the use of coastal aquifers on the upwelling of ground water in the water-tidal zone and below mean low water, and on the importance of this ground water outflow to marine life in coastal areas."

As water demand increases the potential does exist for the desalinization of sea water. Although current costs of this process are high, a combination of this with nuclear power generation and mineral extractive activities is possible. This is particularly true of the New York-Long Island area. This activity could have a severe impact on the salinity of the coastal area in terms of the waste products generated. Stringent regulations will need to be developed with regard to the deposition of brine.

The rapidly increasing demand for electric power combined with the constraints upon upland water supplies and land space will necessitate the location of new generating plants on the coast. Here the industry has access to almost unlimited supplies of water and, especially in the northern areas, water of sufficiently low temperature to provide efficient cooling. The potential effects of the heated effluent on the biota of these areas is not yet sufficiently understood, but the potential does exist to put such discharge to use for aquaculture.

A more detailed treatment of cooling waters may be found later under analysis of the selected problem of thermal effects.

WATER POLLUTION

Nature of the Problem. The problem to be considered here is defined as--how to reconcile the disposal of waterborne wastes with other human uses of the coastal zone in an economically and environmentally acceptable way for now and for the future.

Pollution, itself, is thought of in different ways. Some hold that it is any addition to an environment which causes a significant change in the environment. Most emphasize "undesirableness" rather than "change" and thus relate pollution to human value judgments. Under this concept water pollution is considered to occur in the coastal zone when any input into the water cycle alters coastal water quality to the extent that a coastal use is impaired or lost (168). This definition follows the current central concept of water quality control: people inputs should guide the necessary value judgments as to which water uses should govern in the future. These judgments can then be translated technically with varying degrees of refinement into physical-chemical limits beyond which the water quality will be altered to the extent that the previously selected uses are impaired or lost.

However water pollution is defined, note that the focus of this analysis, as defined above, is slightly different. It does not aspire to "eliminate pollution," however defined. Instead it seeks to reconcile requirements to dispose of some wastes by waterborne means with the requirements of other coastal uses. Instead of "eliminating," it seeks to harmonize and implies that in so doing some tradeoffs between conflicting goals will be necessary to avoid sub-optimization.

Many billions of dollars are being contemplated for water pollution abatement throughout the North Atlantic Region. No sharp breakdown of these costs has been attempted herein to distinguish between coastal and non-coastal pollution abatement because of the pervading interrelationship between pollution in estuaries and pollution in the rivers which feed them. Frequent references to this interrelationship will be made throughout.

Because water pollution is such a vast subject, it is necessary to limit the coverage at the outset. This analysis addresses those broad classes, by source, of water pollution which are generally included in the terms municipal, industrial and agricultural. Specifically, it does not include thermal pollution abatement and solid waste disposal aspects, because these are covered in other problem analyses. It also does not cover air pollution, since this subject is beyond the scope of the overall NAR study, although some significant interrelationships are suggested.

Another type of pollution not explicitly treated herein is "natural pollution," the difference between the water quality which would hypothetically exist without man's presence and some ill-defined and even more hypothetical "ideal." Thus most sedimentation is sometimes considered a form of natural pollution, but such a label becomes very confusing when one recognizes that sedimentation is responsible for much of the wetlands, coastal plains and other land forms which seem to be so valuable today. Nature probably affects water quality much more than man; however, these natural effects usually come about very gradually. Therefore the things that have survived, including man, usually regard these natural effects as "good," i.e., well suited to their own well being. In contrast, man-made changes are usually more abrupt and proceed at a pace somewhat faster than evolutionary accommodation can conveniently match. Thus for reasons of definitional uncertainty and evolutionary accommodation, natural pollution is not explicitly considered herein. However, it implicitly underlies every other form of water pollution under the assumption that the water quality inherited from nature, and the ecosystem which depends upon it, provide a useful point at which to begin. For some special studies, many will want to take apart this very sweeping generalization. For example, some researchers have suggested that the natural background rates of fecal coli are about the same as the rates induced by the concentrated presence of man (11). Furthermore, even when the human and other life systems have accommodated to "natural pollution," they can often benefit by change in these natural conditions.

In keeping with the framework nature of the overall NAR study, this analysis emphasizes breadth. Thus it attempts to bring many significant factors to the forefront, but it does not penetrate them in detail. Therefore frequent generalizations are necessary. Probably all of them are subject to some adjustment when more detailed site-specific attention is focused on any individual problem. A more definitive regionwide treatment of water quality is given in Appendix L (Water Quality and Pollution). Related Public health aspects are discussed in Appendix V (Health Aspects).

Major Causes. The principal reasons for considering water pollution to be a very significant problem in the coastal zone include: present and increasing quantities of wastes (demand), the limited assimilative capacity of the receiving waters (supply), the consequences of not reconciling this demand and supply, and the difficulties in accomplishing the reconciliation. Each of these four major classes of causes is further developed below.

The first major cause is demand. As used here it is the need to dispose of large and increasing quantities of waste from population, industrial and agricultural sources.

Population growth is well documented. (Appendix B-Economic Base.) The current NAR population is estimated to about double by the year 2020. The tendency to concentrate in urban areas is also well established. According to some estimates the nation's population was about 40% urban in 1900, is about 70% today and will be about 80% by the year 2020. Well within the 50-year time frame of the NAR Study, the long-predicted supermegalopolis, extending from Boston to Norfolk, with some gaps especially near its southern end, is expected to become a reality.

The nation's ocean-bordering counties contain 40 percent of its manufacturing plants (131). Figure U-5 depicts the rapid increase in industrial wastes. It is unwise to project this relationship to the year 2020 because recycling and other potential solutions can have a significant effect on the trend. Industrial discharges far exceed all the sewered population of the United States in terms of biochemical oxygen demand (BOD). Over half the volume comes from four major industry groups--paper, organic chemicals, petroleum and steel. Although the total treatment cost is high, it has been estimated to average only about 1% of gross sales (43). Of course, there are other dimensions to the industrial wastes part of the problem besides those revealed by a BOD forecast. Also important are organic and inorganic chemicals and heavy metals such as those shown in Table U-5 . A heavy metal such as lead can be introduced to coastal waters in many ways either directly through shotgun pellets which are ingested by wildlife, indirectly through airborne precipitates originating from automobile exhausts, or through phenomena not influenced by man. Whatever the cause, the effects on marine life are produced by its concentration in ecologically important areas.

Livestock in the region currently produce a BOD load equivalent to that of about 82 million people. The significance of this load will increase greatly with expected shift to feedlots. The processing of forestry products such as paper and pulp also produces very large BOD loads in the region--equivalent to that of 1.3 billion people. Agricultural chemicals also run off into streams which carry pollutants to the coast. For a description of agricultural pollutants, see Appendix L, Water Quality and Pollution . It assesses the magnitude, significance and controls for sediments, animal wastes, processing of agriculture and forestry products, plant nutrients, chemical exotics and infectious agents.

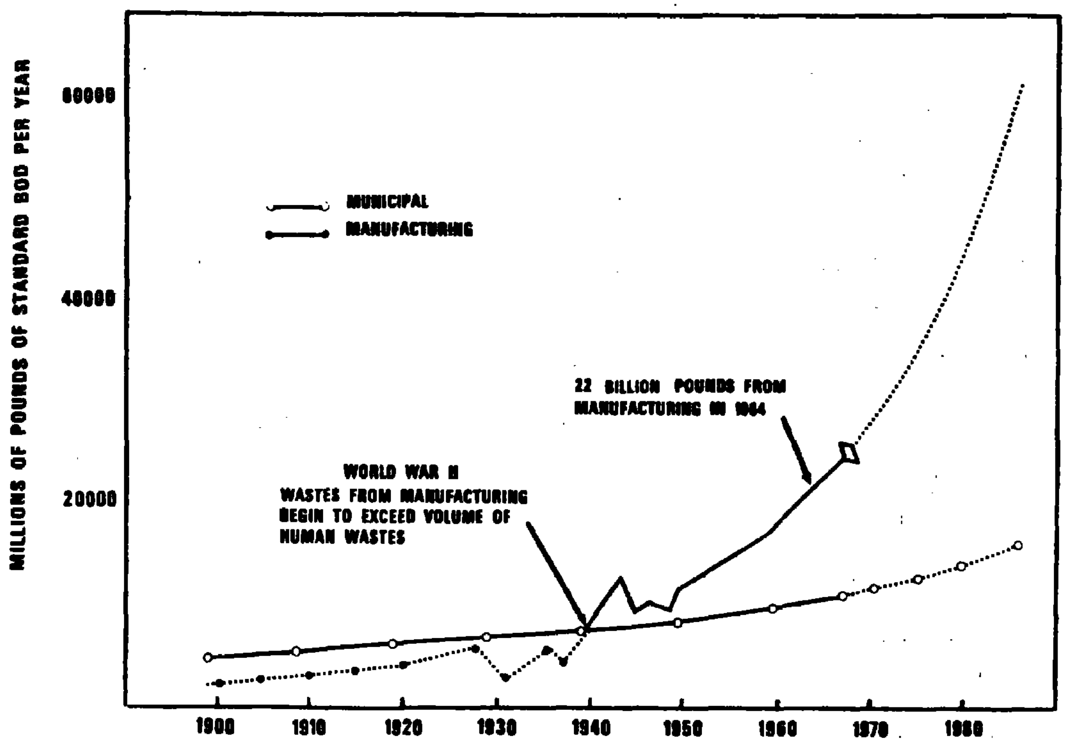
Whether pollution is generated by either the municipal, industrial, or agricultural activities of man, there are other useful ways of looking at water pollution sources. One way is to distinguish between point and non-point sources.

Prominent point sources of municipal water pollution are the outfalls from sewer systems. Industry accounts for other important point sources through their own outfall; through oil spills induced during oil extraction, transportation and use; through dredging, which does not introduce the pollution but can resuspend it or move it; and through industrial introduction of radionuclides. Boat pollution is often considered a point source. Quantitatively it contributes something in the order of 1/10 of 1% of coastal pollutants (89), but it can concentrate fresh pathogen-containing wastes in sensitive

OXYGEN DEMANDING WASTES - UNITED STATES

TOTAL PRODUCTION* OF DOMESTIC AND MANUFACTURING WASTES

1900-1985



SOURCES: "The Cost of Clean Water," FWPCA 1968; Federal Reserve Board Index; Census of Population, Bureau of Census; Water Resource Council Projection.

*Data Shown in Terms of 1964: One FRB index point of industrial production = 166 million pounds of Biochemical Oxygen Demand (BOD_5) per year. No adjustment was made for: product mix, sewering or waste treatment.

NOTE: Biochemical Oxygen Demand (BOD_5) is defined as the amount of oxygen used in a given time period and at a given temperature by bacteria that break down organic materials in water (usually 5 days at 20°C).

SOURCE (131) FIGURE U-5

TABLE U-5

CHARACTERISTICS OF SOME COMMON METALS OF
CONCERN IN THE ESTUARINE ENVIRONMENT

Metal	Chemical Symbol	Natural Concentration in Sea Water (mg/l)	Range of Concentration That Has Toxic Effects On Marine Life (mg/l)
Silver	Ag	.0003	Highly Toxic
Arsenic	As	.003	2.0
Cadimum	Cd	.08	0.01 to 10
Chromium	Cr	.00005	1.0
Copper	Cu	.003	0.1
Mercury	Hg	.00003	0.1
Lead	Pb	.00003	0.1
Nickel	Ni	.0054	0.1
Zinc	Zn	.01	10.0

NOTE: • The figures in the last column are only broad indicators. They do not, for example, reflect the synergistic effect of one element magnifying the toxicity of the other. The last column indicates the lowest concentration found to be toxic in any of the species tested. For example, this concentration was 10.0 mg/l in the most zinc-sensitive species tested. If for some reason the natural zinc concentration in seawater were doubled and the most zinc-sensitive species multiplied this concentration through its food chain by a factor of 500 to a level of 10.0 mg/l, that particular species would die out in the locality affected by the concentration. The other species would not die until increases in the background rate combined with concentrations in their food chains produced concentrations in their bodies somewhat higher than 10.0 mg/l. However, the surviving species would be affected indirectly to varying degrees as the local ecosystem readjusted to the loss of the most zinc-sensitive species.

• This phenomena, of course, is nothing new. The differential distribution of "food" and "poisonous" elements and the differential ability of species to concentrate and be affected by these elements (sensitivity) create limiting factors which account for much of the diversity and distribution of plants and animals throughout the earth on both land and sea.

• What is "new" is the relative suddenness of some of the changes man introduces. Considerable time might be required for an affected ecosystem to achieve a new equilibrium. During this process of readjustment, neighboring species, including man, can be predictably or unexpectedly affected.

SOURCE: Tabular information extracted from (131).

localities such as marinas and shellfish areas. All of the point sources introduce both problems and opportunities. They cause problems by concentrating wastes and thereby overtaxing dilution capacities. On the other hand, by concentrating wastes, the point sources provide opportunities to employ major economies of scale in waste treatment.

In marked contrast to point sources, non-point sources are elusive to measure and control. Prominent non-point sources include precipitates from airborne pollution; agricultural runoff of oxygen-demanding substances, pesticides, herbicides and fertilizers; storm runoff; ground-water contaminants; and resuspended pollutants previously deposited in water courses. Some recent studies have emphasized the relative importance of non-point sources vis-a-vis point sources. Iowa reports, for example, that the fecal coli count in its streams is dependent upon non-point sources. The highest coliform count in its streams comes at high flow when precipitation washes animal fecal material into streams (18). In another study of the Millstone, Upper Raritan and Upper Passaic Rivers (162), the researchers attempted to correlate the input of the known point sources of BOD with the BOD levels actually found in the water courses. They concluded that less than 40% of the observed organic loading in the water courses could be attributed to known point sources. Stated another way, even if treatment of these point sources should be improved to absolute perfection (100% removal), less than 40% of the problem would have been solved. There is a great need to verify these results in the study area and elsewhere because their implications are so significant. At present we know relatively little on how to measure these sources, much less on how to control them economically.

Not falling conveniently under either point or non-point sources is salinity. Salinity concentrations are affected by such things as river flows; the quantity, location and movement of surface and subsurface water; the flushing characteristics of tidal areas; and climate. Increases, decreases or stabilization of salinity concentrations are not categorically either beneficial or detrimental; it depends upon the water use. For example coastal agricultural, water supply and wildlife uses generally favor reduced salinity while various species of marine life favor salinity reduction, stabilization or increase. As implied above, salinity changes, whether "good" or "bad," can be influenced by either nature or man. To reach sound conclusions in the numerous instances where options are possible, a much better basic understanding is needed on the incremental effects of salinity changes on all coastal uses.

A second major cause of the problem is supply. As used here it is the capacity to assimilate wastes.

All matter and energy seem to be part of a gigantic natural recycling system whose broader dimensions are global and epochal. In this system matter and energy can be thought of as moving from one temporary "sink" to another through a distinguishable number of transitional processes such as ingestion, decomposition, evaporation and erosion. One of the major classes of sinks is "precipitates" both organic and inorganic. Propelled by dynamic forces, especially the influence of gravity on water, precipitates tend to collect at the lowest elevations. These are usually the oceans. The accumulation is especially conspicuous where rivers enter the ocean. There precipitates tend to pile up and frequently become resuspended in the water column. Whether this accumulation is desirable or not depends upon how it influences other uses of the coastal zone.

The important thing is to know the magnitude and significance of the matter and energy which are entering our coastal waters, their effects and the alternative ways of influencing this admixture to improve the total usefulness of the coast.

The ability of the ocean to absorb a certain amount of waste with beneficial, neutral or acceptably deleterious effects on other uses is the measure of its value for waste disposal purposes. If this assimilation capability is abused, significant short and long-range harm might be done to the entire system, including man.

A water body assimilates wastes when it reduces them to a harmless or desirable form through some physical, chemical or biological process and also when it reduces their concentrations to acceptable levels. Assimilative capacities vary greatly. Probably the most important factor is dilution. Inland, one of the most significant approaches in mitigating pollution is increasing the dilution capacity of water courses especially during periods of high load and low flow. Although man-introduced pollutants have been observed far out to sea (DDT has been detected in the Antarctic), it is certainly true that relative to inland waters, the oceans provide a far greater dilution capacity. It would thus seem, considering the overall good, that some waste disposal activities of man should more logically be located on the coast where the flushing characteristics are the best. Notwithstanding this observation, there are some real and significant limitations to the dilution capacity of coastal waters, especially estuaries. These limitations include:

- The pollution trap formed in those estuaries in which net water velocity drops off sharply as pollution-laden rivers enter tidewater.

- The usual location of major urban areas adjacent to these pollution traps. The load on the estuary is greatly increased and the unpleasant effects of pollution are more prominently exposed to many people.

- The great sensitivity of some marine life to change, a sensitivity acquired through evolution in a relatively changeless oceanic environment, and

• The well documented concentration of toxic materials by marine life through the food chain to an extent that man is directly or indirectly harmed.

A third major cause of the problem is the consequence of not matching demand with supply. The inability to match the waste disposal requirements of man with his requirements for water of various qualities can produce many conflicts between uses of the coastal zone. Some of these conflicts were illustrated earlier in Figure U-4 . They are considered in further depth later in this analysis (Parties Affected).

A fourth major cause of the problem is the difficulty of matching demand with supply. Within the NAR costs have been estimated at about $50 billion to reach and maintain currently approved standards to the year 2020 and another $50 billion to improve the quality beyond these standards to meet regional objectives. (Appendix L - Water Quality and Pollution). The states in the NAR have increased their construction of waste treatment facilities greatly in recent years. For example, 7 of the NAR's 12 coastal states are ranked in the top 14 in the nation in terms of increased investment in 1967-69 compared with their 1962-66 average (149).

Water pollution is often cited as <u>the</u> prime example of an external diseconomy. If the user of water is not required to return it in the same condition as he received it, he will avoid some costs but only at the expense of other users who are hurt by the degraded water quality. As long as the polluter is not charged with the effects, there is an understandable tendency in this competitive world for him to underplay treatment or other costly alternatives. External effects are usually but not always negative. Many examples of beneficial thermal and nutrient enrichment are known and in most of these cases, the enricher does not benefit by his contribution.

Knowledge gaps in water pollution control are too numerous to cover comprehensively herein. Some of the major knowledge gaps are: (1) the effects of different degrees of water quality improvement on the environment and the incremental costs and benefits associated with these improvements; (2) the significance of non-point source pollutants and the means of controlling them; (3) methods for systematically integrating pollution control efforts regionally; (4) mechanisms of various transport and transformation processes influencing pollutant concentration in coastal waters; and (5) economical methods of overcoming problems introduced by combined sewer systems and by chemicals like nitrogen, phosphorus, organic carbon and heavy metals. An excellent report on knowledge gaps in wastes management in the coastal zone was recently released by the National Academy of Sciences and the National Academy of Engineering (73).

Location. As mentioned earlier the ocean has a great, but far from infinite, capacity to dilute wastes. Dilution capacity has a major influence on the location and severity of coastal pollution problems.

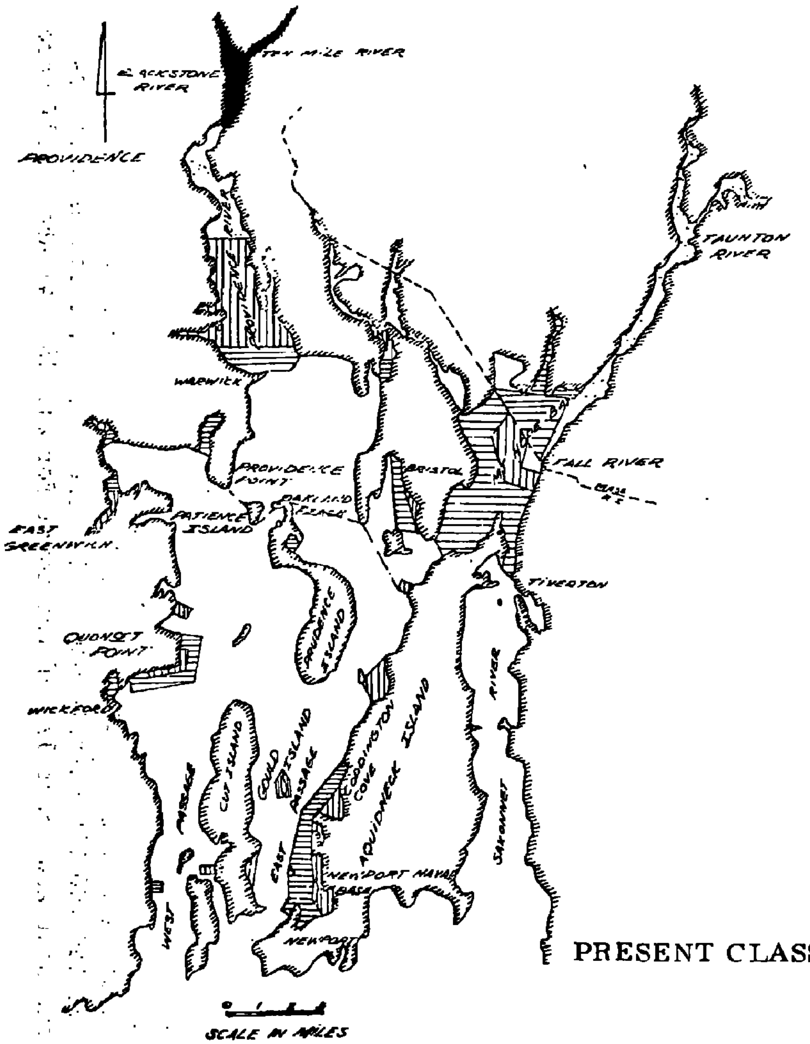
The most significant coastal pollution problems in the NAR occur in constricted estuaries located downstream from urban concentrations. Examples are the Charles, Taunton, Providence, Hudson, Passaic, Raritan, Delaware, Patapsco, Potomac and James Estuaries.

Figure U-6 depicts a typical situation in this region, Narragansett Bay. Note that pollution is concentrated almost exclusively in the finger-like sub-estuaries. When these feeder estuaries enter the major part of the bay, water quality improves to the highest classification. The more restricted the dilution capacity at the heads of the sub-estuaries, the worse the water quality.

Two other typical causal factors are operating in Narragansett Bay to fix the location of the worst pollution. One is adjacency to urban centers clearly illustrated by the Providence and Taunton Rivers. The second is tidal effects. In some locations the boundary configurations of an estuary are such as to cause the tide to act as a dam, delaying the riverine flow and causing the estuary to become a sediment trap. It is hard to form generalizations on net tidal effects. In some locations the tide serves to increase net flushing and at others it decreases it. As an example of the latter, estimates are that "the mean residual time of pollution introduced in the Hudson River--can be as long as 400 days" (41). Detailed observations and studies are usually necessary to predict even the direction of the effects of proposed changes in estuarine boundary configurations.

Other pollution problems occur in almost completely enclosed, poorly-flushed back bays close to high population densities. An example is Great South Bay on the south shore of Long Island.

On the open ocean coastline, with one major exception, pollution is possibly less of a problem than it is anywhere else in the continental United States. The exception is massive oil spills which can affect the open ocean coast as well as estuarine coasts. Considerable attention will be given to oil spills later in this Appendix. (See Parties Affected under the analysis of Marine Transportation.) In an evaluation of 38 spills of 2,000 barrels and over a recent study (17) indicated that: 1) 75% were associated with vessels, mostly tankers; 2) 80% of the oil spilled was crude. Although residual oils made up only 1% of the spillage, they were involved in nearly half the spills. 3) The Torrey Canyon which spilled 700,000 barrels was by far the largest, twice as large as the next and about 1/3 of the total for all 38. 4) About half were



Water Pollution Classification

- Class SA - Suitable for all sea water uses including shellfish harvest for direct human consumption (approved shellfish areas), bathing, and other water contact sports.
- Class SB - Suitable for bathing, other recreational purposes, industrial cooling, and shellfish harvesting for human consumption after depuration, excellent fish and wildlife habitat, good aesthetic value.
- Class SC - Suitable habitat for fish, wildlife and non-harvestable shellfish; suitable for recreational boating and industrial cooling; good aesthetic value.
- Class SD - Suitable for navigation, industrial cooling, and migration of fish; good aesthetic value.
- Class SE - Nuisance, unsuitable for most uses.

PRESENT CLASSIFICATION OF NARRAGANSETT BAY WATER QUALITY

SOURCE: (31) FIGURE U-6

within a mile of shore and nearly all were within 10 miles. At the average rate of oil movement of 1/2 knot, an onshore wind could move oil to the shore in two hours in about half the incidents. 5) The spills lasted 3 to 100 days with the median duration of 17 days. 6) The median length of coast contaminated was 7 miles. None except the Torrey Canyon was over 40 miles. 7) 75% occurred within 25 miles of a port. 8) The principal environmental factors which affect the severity of spills are: sea conditions, wind direction and velocity, surface currents and tidal effects, water temperature and general atmospheric conditions. 9) Before and after observations have not yet been adequate to distinguish environmental impacts caused by oil spills from other natural background phenomena which also affect the environment. Nevertheless, available information indicates that marine birds in the vicinity are usually badly hurt. The effects on shellfish appear fairly temporary and even when high mortalities were observed, complete recovery apparently occurred in six months to two years. (However, see pages 133 and 134 for further discussion.) Finfish were not affected and no lasting effects on the food chain were observed. 10) Other than on marine life, the spills affected shoreline recreation, aesthetics and land use. The impacts varied with the season, and duration and with the intensity of use foregone.

Time Characteristics. Most of the contributing factors just mentioned--constriction, urbanization and tidal effects--are present in all seasons. The problem is therefore primarily a constant one with some worsening in the summer although not nearly to the degree experienced inland.

There are many reasons why coastal pollution tends to be worse in the summer. As temperatures rise, the quantity of dissolved oxygen water can hold drops off just at a time when the rate of decomposition (biochemical oxygen demand, or BOD) increases. This usually occurs during a period of decreased seasonal freshwater inflows and at a time when people have their closest contact with the water. Marine life is operating near its maximum temperature threshold and is generally much more prone to water quality deterioration than at other times. In a few poorly flushed coastal areas such as Arthur Kill between Staten Island and New Jersey dissolved oxygen can reach zero and anerobic decomposition can occur with attendant odors and fish kills.

In contrast to most coastal pollution, which despite its summer peak is usually a year-round problem, massive oil spills are more of an all-or-nothing event. With respect to any given locality they are relatively rare, but in aggregate their frequency is increasing.

Over the long-range, it is difficult to predict whether coastal water quality will improve or degrade. Certainly without the current and anticipated scale of effort, coastal pollution would become increasingly severe. Many billions of dollars will be spent in this region to control pollution, but whether this massive effort will be of a scale to compensate for growth-induced pollution, is not fully known.

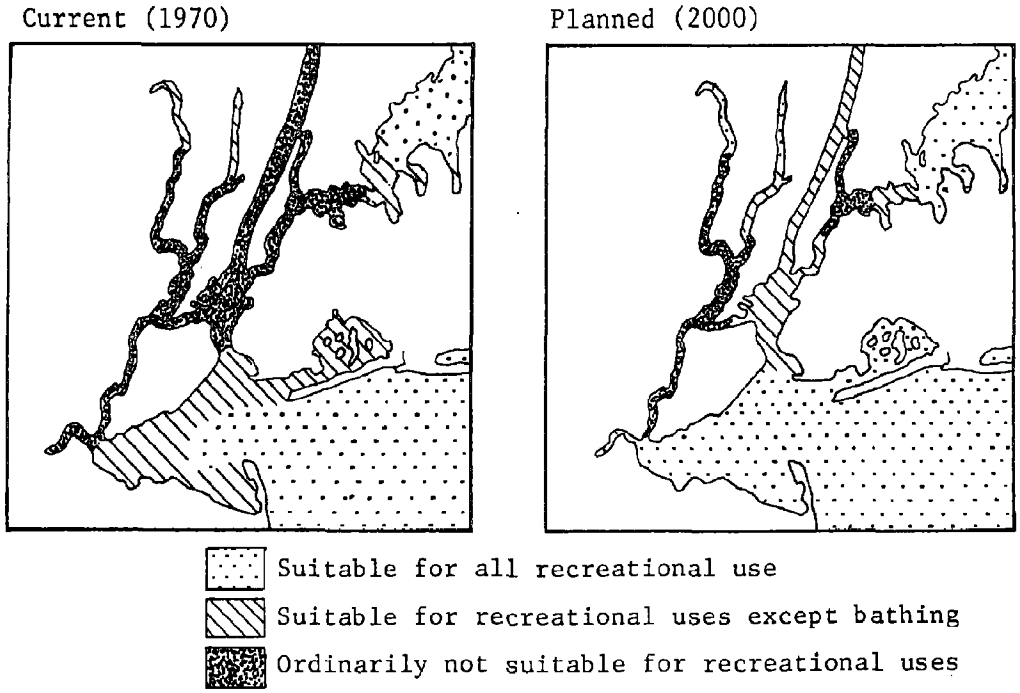
Parties Affected. Efforts to identify and quantify actual major losses attributable to coastal pollution have been somewhat unfruitful. A clear exception is the shellfish loss, especially the loss incurred from restricting the human consumption, without prior depuration, of oysters growing in some waters. The research organization, which prepared "Case Studies of Pollution Damage to Estuaries" for FWPCS in 1969 (Contract No. 14-12-473, has stated: "In spite of the tremendous amount of material appearing in print regarding water pollution, it is extremely difficult to find examples of well documented, scientifically investigated situations, where there is no doubt that pollution, in its broadest interpretation, is the cause of the problem observed. .... Authors and government authorities are reluctant, or perhaps unable, to reach a definite conclusion as to the fact that pollution did in fact cause the damage observed. The second difficulty occurs when one tries to attach a dollar value to the loss." (61)

One way of partially overcoming this identification problem is to reverse the coin -- to see who might benefit from a significant planned increment of improvement in coastal water quality. The question will be examined in terms of a specific and important example. The Greater New York Area has an extensive plan with a time oriented goal to improve water quality. The Interstate Sanitation Commission (ISC) operates in the tri-state area within about 50 miles of the southern tip of Manhattan Island. Figure U-7 depicts the difference between the current and planned water quality in terms of commonly cited usages. Should this quality improvement be attained, uses of coastal waters in the vicinity might be improved as suggested below.

Commercial fishing should benefit to the extent that improved water quality increases the fish catch. Safety, congestion, economics and other considerations would probably still limit commercial fishing in some of these areas despite the water quality improvement. The outermost areas such as Jamaica Bay, New York Bight and Western Long Island Sound are more likely to be opened to possible increases in commercial shellfish operations. The magnitude of any likely increase has not been estimated. The dockside value of commercial fish taken in the waters surrounding all of Long Island and the metropolitan area in recent years has averaged about $12 million annually.

PLANNED IMPROVEMENT IN COASTAL WATER QUALITY

Greater New York Area



SOURCE: (122) FIGURE U-7

The waste disposal program will cost the area, -- and the state and National governments which will carry part of the cost --, about $6.4 billion for sewage collection and treatment facilities to the year 2000. Of this $6.4 billion, about a third or $2.1 billion is for upgrading water quality from its current to its planned level as shown in Figure U-8. The remaining $4.3 billion is to maintain the planned quality in the face of expected growth (122). The $6.4 billion cost (1963 dollars) was compiled several years ago and should be adjusted upward to account for the increase in the cost index of the construction of sewage facilities and the increases in state and Federal requirements over those set out a few years ago. It does not include measures to control water pollution from other closely related sources such as combined sewers and non-point sources, the cost of private facilities such as required for industrial discharges and the cost of operating and maintaining the facilities.

Recreation should benefit, if other problems of shoreline accessibility and desirability for bathing can be overcome. Some of the outer beaches now closed regularly or intermittently could become available for swimming. The benefit would accrue about 90 days annually and peak on about 10 summer weekends. The costs of pollution abatement plus considerations of safety and beach desirability have apparently been judged to be just too high to make it feasible to open up even more beaches to recreation.

A number of factors limit the extent of recreational boating in the New York metropolitan area. Among them are water quality, seasonality, port congestion, safety, and marina and launching facilities. Figure U-7 shows that the water quality limitations, especially in the inner harbor and Hudson River are planned to be removed. The effect of this improvement on recreational boating in these areas is unknown, especially in light of the probable continued existence of the other limitations.

Little sports fishing now occurs in the metropolitan area. Planned water quality improvements, if accompanied by other measures to make the metropolitan shorelines more accessible and attractive, should increase participation; however, water quality improvements may not be sufficient to encourage the human consumption of fish caught in the vicinity.

Aesthetic satisfaction is probably the use that will benefit most from coastal water quality improvement. To see why and how, the catchall "aesthetics" needs some dissection.

First, consider the most tangible part of aesthetic satisfaction-the satisfaction directly perceivable by any of the physical senses. Call it "sensible aesthetics". It is very unlikely that water quality improvements in the urban coastal waters will have a significant, direct impact on the senses of a substantial portion of the urban populace. Unless the beholder approaches very close, pollution cannot be perceived by his eye. Exceptions are floating debris and oil slicks, but these two problems represent very little of the $6.4 billion planned for sewerage programs. Floating debris is considered in another problem of this appendix (Solid Waste Disposal). In a few highly localized areas such as the Arthur Kill on hot days the sense of smell will be offended in those who need to or desire to move close enough to the water to preceive it. The other physical senses are indifferent to pollution, recognizing that the waters will not be actually drunk. To do that, if practicable, would require desalination which would probably remove pollutants in the process.

The indirect visual effects are probably greater. Thus, if improved water quality results in more sailboats on these waters, the aesthetic satisfaction of the beholder would be unquestionably enhanced. To the extent that improved water quality increases marine life sufficiently to cause many to move to the water's edge to preceive this life, aesthetic satisfaction would also be enhanced.

Next, consider a more elusive form of aesthetic satisfaction --

human satisfaction which is not ascribable to sense perception. It could be called "suprasensible aesthetics". It might be here that coastal pollution control in urban waters has its big human payoff. When people, who are aware that pollution abatement programs will not greatly improve their own direct uses of the coastal water, approve bond issues and referendums, they appear to demonstrate a clear willingness to pay the cost. Although this "gut feeling" is elusive, it is very real. It seems to account for the major part of the multi-billion dollar program.

Another important public benefit which can be entered under aesthetic satisfaction for want of a better place to put it is the feeling of satisfaction in adopting a safeside approach to uncertainty. Currently, there is much speculation that water pollution could irreversibly change the oceanic ecosystem with great long-range effects on the health and general well being of mankind. Until these hypotheses can be reliably confirmed or dismissed, people have demonstrated a marked readiness to bear substantial additional costs for safety.

Water quality improvement has little effect on national defense or marine transporation except as they contribute to water pollution and must bear their share of the cost of its control.

Coastal land owners are affected to the extent that the value of their land is based upon any of the other coastal uses cited herein. Thus, for example, coastal lands used for bathing are much more affected than coastal lands used for transporation. To assess this value better, there is a need for studies of changes in urban land values brought about by changes in water quality.

Solutions. Notwithstanding numerous inland interrelationships, it has thus far been relatively easy to describe the problem in a coastal context.

When it comes to solutions, however, it becomes somewhat artificial to distinguish the coastal aspects from the overall improvement of water quality -- from inland source to, and including, sea. For example, efforts to disaggregate program costs in terms of coastal and non-coastal components do not yet appear very rewarding. Only general solutions can be considered in this analysis. Site - specific solutions for each area require more detailed study.

In identifying and considering solutions, therefore, this analysis will list some major elements or stages of a systematic water quality improvement program. These stages may be considered as key points at which alternative decisions can importantly influence the degree of desired coastal quality improvement attainable with a finite commitment of resources. At each stage alternatives multiply, not only from the choices which can be made at that stage, but also from the relative degree of emphasis given the stage. Thus, the first listed stage -- the setting of an overall objective -- can beget numerous alternatives greatly affecting every subsequent stage. A failure to articulate an overall objective and to review subsequent steps in terms of it can result in a decentralized, and possibly ambiguous and ill-aimed program. Similarly, alternative ways of wording this overall objective should greatly influence a wellmanaged coherent program.

To provide an intitial overview the stages have been itemized and broadly classified in Table U-6 as institutional and technical. Subsequent commentary on each stage is provided only in enough depth to explain the stage, suggest its overall and/or coastal significance, point out some alternatives, and sometimes express a preference for one of the alternatives.

Before considering each stage, a few further preliminary comments applicable to them are necessary.

- Completeness - An effort has been made to be comprehensive, however, the list of stages is not complete. Other stages, and alternatives within each stage, existing and in the future, can be added. The list can serve as a framework within which additions can be located systematically with respect to those already identified. The principal purpose of the framework is to display the very important concept that there are multiple approaches which should be considered in the solution to the problem in each coastal area. To concentrate almost completely on one such as treatment plants can be narrow and inefficient.

- Sequence - Some attention has been given to listing the stages in a logical sequence. However, there is considerable overlap and feedback between them all. For brevity and simplicity this overlap and feedback will usually not be identified, but its application throughout should be kept in mind.

- Research - Significantly rewarding research can be undertaken to improve performance at each stage, but for brevity this need will be articulated in only a few illustrative cases.

Each of the stages selected for representation in Table U-6 will now be discussed briefly in the same order as they are displayed in the Table.

Set Overall Objective. It is of fundamental importance that a carefully constructed meaningful objective be articulated at the outset to reduce the possibility of substantial effort being expended on an inaccurate premise. The overall objective used herein is:

TABLE U-5

SOME STAGES IN DEVELOPING POLLUTION ABATEMENT PROGRAMS

Institutional

1. Set overall objective
2. Establish goals (assigned uses) to meet objective.
3. Establish criteria to meet goals.
4. Establish incremental relationship between benefits of meeting goals and costs incurred thereby.
5. Identify sources and quantify and quality them in terms of established criteria.
6. Predict relationships between waste sources and recipient water quality.
7. Select plant and outfall locations
8. Establish controls.
9. Implement technical methods selected.
10. Monitor water quality.
11. Enforce.
12. Distribute costs.
13. Make regional systems analyses.

Technical

Before Treatment

1. Redesign industrial processes.
2. Recycle.
3. Improve degradability of wastes.
4. Restrict some usages.

During Collection, Treatment and Disposal

1. Collect from point sources.
2. Collect from non-point sources.
3. Select locations.
4. Select degree of treatment.

At Disposal Area

1. Retain effluent.
2. Augment low flow.
3. Improve flushing characteristics.
4. Aerate in-situ.
5. Remove bottom sediments.
6. Coat bottom sediments.
7. Minimize remaining effects.

> To reconcile the disposal of waterborne wastes with other human uses of the coastal zone in an economically and environmentally acceptable way -- for now and the future.

This wording does not try to maximize waste disposal, water quality, economics, environment, the now or the future -- but it does prominently and explicitly establish their interrelationships at the outset and implies that solutions will generally be tradeoffs. How this can be done provides the basis for subsequent analysis. There are, of course, other ways of expressing the governing objectives, but however, it is worded, it should be done at the beginning -- even if after later analysis it may require some sharpened rewording.

Establish Goals. The first step in meeting the broad objective would be to break it down into more tangible goals, the accomplishment of which would achieve the objective. The current method appears excellent; the major use which requires the highest quality, is designated for each part of the coastal waters. To obtain the views of people who use these waters, public hearings are held. After considering this and other information such as costs, the affected states recommend use classifications. Although there are some differences among states, the use classification shown in Figure U-6 and Table U-7 is representative. Since coastal waters for the most part have been classified interstate for this purpose, the state recommendations require approval by the U.S. Environmental Protection Agency. With minor exceptions, the recommendations of all the coastal states in the NAR have received this approval. Of course, as additional information becomes available on the benefits and costs of achieving these use classification, they may be adjusted either upwards or downwards. Provided a reasonable flexibility is retained to make these adjustments, this system is excellent in providing a basis for later stages.

Establish Criteria to Meet Goals. The environmental requirements of each of the above designated uses provides the basis for establishing water quality criteria. "Criteria", used throughout for consistency, is the same as "standards." In most pollution abatement literature the two terms are used interchangeably. In general, coastal water quality requirements are highest for shellfish harvesting with bathing, boating and landscape visual quality following in that order. For additional indepth description and analysis of criteria, see (93) and (150). Table U-7 is representative of the type of use-oriented criteria currently established. Just as the recommended uses must be approved by the U.S. Environmental Protection Agency, these implementing criteria must also be so approved. With some exceptions, the criteria have received this approval in the NAR's coastal states. Again provided a reasonable flexibility is retained to make adjustments as additional knowledge emerges, this system is also excellent in taking the analysis down to the next lower level.

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION
CLASSIFICATION AND STANDARDS OF QUALITY FOR COASTAL AND MARINE WATERS
(As Revised and Adopted April 18, 1967)

WATER USE CLASSES	DESCRIPTION	STANDARDS OF WATER QUALITY						
		DISSOLVED OXYGEN	Sludge deposits - solid refuse - floating solids - oil - grease - scum	COLOR AND TURBIDITY	COLIFORM BACTERIA per 100 ml	TASTE AND ODOR	pH	
CLASS SA	Suitable for all sea water uses including shellfish harvesting for direct human consumption, (approved shellfish areas) bathing, and other water contact sports.	Not less than 6.0 mg/l at any time	None allowable	None in such concentrations that would impair any usages specifically assigned to this class	Not to exceed a median MPN of 70 and not more than 10% of the samples shall ordinarily exceed an MPN of 230 for a 5 - tube decimal dilution or 330 for a 3 - tube decimal dilution (See Note S.1)	None allowable	6.8 - 8.5	
CLASS SB	Suitable for bathing, other recreational purposes, industrial cooling and shellfish harvesting for human consumption after depuration; excellent fish and wild life habitat; good aesthetic value.	Not less than 5.0 mg/l at any time	None allowable	None in such concentrations that would impair any usages specifically assigned to this class	Not to exceed a median value of 700 and not more than 2,300 in more than 10% of the samples (See Note S.1)	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.8 - 8.5	Allowable Temperature Increase (Note 2) Chemical Constituents (Note 3) Radioactivity (Note 4)
CLASS SC	Suitable fish, shellfish and wild life habitat; suitable for recreational boating, and industrial cooling. good aesthetic value.	Not less than 5 mg/l during at least 16 hours of any 24 hour period nor less than 3 mg/l at any time	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.5 - 8.5	
CLASS SD	Suitable for navigation, power, and certain industrial cooling water; migration of fish; good aesthetic value.	Not less than 2 mg/l at any time	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.5 - 8.5	

NOTES

S.1 Surveys to determine coliform concentrations shall include those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

S.2 None except where the increase will not exceed the recommended limits on the most sensitive water use.

S.3. None in such concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.

S.4 The discharge of radioactive materials in concentrations or combinations which would be harmful to human, animal or aquatic life shall not be allowed.

S.5 Coastal and marine waters are those generally subject to the rise and fall of the tide.

S.6 The standards shall apply at all times in coastal and marine waters.

SOURCE (75)

TABLE U-7

Establish Incremental Benefit-Cost Relationships. As difficult as it is, this important step should not be avoided as it often is. "Benefits" and "costs" as used herein are construed in their broadest context to include both monetary and non-monetary considerations. These two considerations can and should be interrelated; knowledge of the monetary costs and expenditures and benefits foregone can provide considerable insight as to whether they should be incurred, increased, or diminished to achieve different levels of non-monetary benefits.

It is a mistake to think of monetary and non-monetary considerations as unrelated. Two examples will bring out the point. In the first example, take as given the fact, that to achieve a certain minor non-monetary benefit great monetary costs will be incurred. If these high costs were distributed elsewhere to provide other environmental improvements or social improvements such as education, welfare or tax relief, a much greater total benefit might be attained. In the second example, take as given the fact that only a minor monetary cost will produce major non-monetary benefits. In this case, there is no question that the program should be undertaken. Arguments which seek to reject economic relationships as irrelevant to environmental issues sometimes produce emotional polarization which is not conducive to rational decision making. Since monetary resources will always be limited, it is very important that they be applied in ways which can produce the greatest overall benefit. There appears to be no escape from this reality.

Accordingly, the highest priority should be given to that form of research which can increase understanding of how incremental water quality benefits are related to incremental costs of achieving these benefits, whether the benefits or costs be monetary or not. Currently, a lack of adequate knowledge in this field, especially with respect to marine life, is one of the greatest impediments to the development of a rational coastal water quality program. To what extent inland and coastal activities should be constrained out of consideration for each other is, unfortunately, inadequately known at present. Increased knowledge here can produce greater overall benefits than it can in probably any other step in program development.

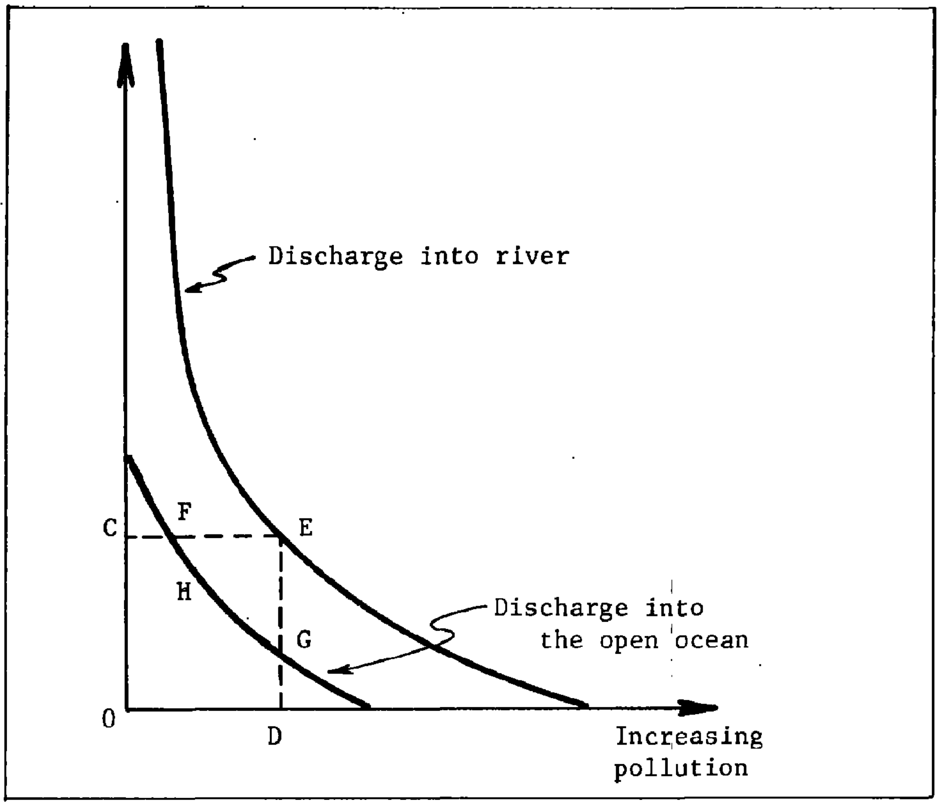
A possible way to begin to require this essential understanding is to use the models developed in the plan formulation part of the NAR study. If they are developed to thier potential a general cost versus water quality curve could be constructed. For example, as dissolved oxygen requirements for a major river entering tidewater are raised, the model will make selections from an increasingly costly upstream set of solutions. These include: improved treatment, jow flow augmentation, instream aeration and relocation or cessation of industrial processes. The derived cost - quality curve could then be related to the value of the coastal uses which require varying levels of dissolved oxygen. Much judgment will still be needed, especially because of unquantifiable environmental factors. Still considerable light will have been thrown upon a decision that is now made largely by intuition. Even uncertainty and environmental intangibles can be examined by introducing them as constraints, and then comparing solution costs with and without the constraints.

Determine Sources. A major step in achieving water quality standards is to identify sources of pollutants which combine to produce ambient water quality. Fundamental to rational analysis is an inventory of pollutant sources showing their location, quantity, quality and temporal variations. As stressed earlier, it is relatively easy to identify point sources, but there is an increasing body of evidence to indicate that the more elusive non-point sources could be of equal or greater significance as a determinent of water quality. For example, it has been reported that in the Los Angeles County area more organic wastes are discharged into the atmosphere than into the Pacific Ocean (73). In that area it is clear that at least one non-point source, airborne precipitates, could be of major significance in developing programs to improve the quality of the water. The identification and analysis of these non-point sources should receive the highest priority unless their significance can be demonstrated to be minor.

Predict Source-Recipient Relationships. When the desired criteria and the pollutants which influence them are known, it is conceptually straightforward to predict how the sources (inputs) of these pollutants affect desired water quality criteria in recipient water bodies. However, practically this is still very difficult. The decay rate of pollutants, chemical and biological interactions and the movement of tidal waters govern the concentration of coastal pollutants at any given time and place. Decay rates and chemical and biological interactions over time require considerably more research. The description of the circulation of most tidal waters often requires very sophisticated and costly analysis, especially when effort is made to predict the effect of changes. Currently models based on correlation with the observed distribution of dyes provide the best means of prediction. Numerical models and physical models each have their advantages and limitations. In important situations, both may be justified. For analyses of the relative utility of modelling methods, see (133) and (94). Whatever method is used, it is essential that the basic source-recipient relationship be known before costly abatement programs can be rationally contemplated.

Select Plant and Outfall Locations. The siting of treatment plants and outfalls should be influenced not only by economic proximity to the pollution source but also by the locational effect on the receiving waters. This is particularly important in

COASTAL DILUTION BENEFIT



Note: For a given degree of pollution, D, effluent treatment costs are far less when discharging into the open ocean, G, than when discharging into the river, E. For a given treatment cost, C, much less pollution results with ocean discharge, F, than with river discharge, E. Between F and G there are opportunities for all to benefit from the superior dilution qualities of the ocean. One such point is H at which both costs and pollution are less.

SOURCE : (31) FIGURE U-8

the coastal zone. To satisfy a given set of environmental criteria, for example, a long ocean outfall with diffusers at the outlet end might be far less costly than increased treatment. Other factors must be considered too. For example, instead of economically venting liquid wastes to the ocean, it might be better overall in some localities to incur increased treatment costs and allow the improved waste water to be used for ground water replenishment or for maintaining minimal salinity concentrations important to other uses such as aquiculture and oyster cultivation. Attention to locational considerations might greatly decrease costs and simultaneously greatly increase water quality as Figure U-8 illustrates.

Reasonable care is assumed in applying this concept. Careful research and analysis would have to be made to prove out the ecological and economical tradeoffs suggested. Sites would probably be concentrated at the many coastal locations where discharge can economically and safely be made into the ocean proper. They would not be located along most estuaries, in busy ports, or in important recreational, conservation, preservation or shellfishing areas.

The point is that the ability to dilute effluent relative to inland water bodies may determine the highest and best use of some stretches of the region's ocean coast. Overall pollution problems are relieved every time a new major pollutor decides to locate in that portion of the nation and region which can best accommodate his effluent.

For many industries, such as the canning industry, the ability to dispose of large volumes of waste economically and inoffensively is the difference between growth and decline. A single sugar beet plant, for example, may generate wastes with a BOD equal to that of a city of a quarter million people (169). To encourage the location of such industries where it is to the best national and regional advantage, will require some change in current approaches. Coastal areas, particularly those in which unemployment and poverty are problems, should understand and consider the option to capitalize on the unique natural disposal capabilities of their areas by advertizing and inducing new disposal industries to locate in these areas. An alternative of requiring all pollutors to treat effluent to the same degree, say secondary, regardless of location, has the virtues of simplicity, enforceability and apparent fairness, but it may result in pollution continuing to be concentrated in inland areas where the effects may be much more deleterious.

Establish Controls. Before embarking on costly treatment programs, the problem can often be reduced in scale by regulations, permits and other controls. Despite the attendant restriction on other human values, controls may often be the best overall solution, provided that the cost of accepting these restrictions is less than the additional degree of treatment required or benefits achieved.

Implement Technical Methods Selected. Numerous alternative technical methods are cited later. The problem of implementing them, however, is an institutional one requiring public acceptance and funding. All of the other steps in this analysis have as their objective the reduction of this particular step to an acceptable minimum. Considering the great variety of tools available, major savings appear very attainable, but they will require a degree of knowledge and sophisticated analysis which needs much more development.

Monitor Water Quality. In many places in this region pollution abatement progress is largely measured in terms of the combined capacity of treatment plants constructed and proposed. Although such a yardstick is delightfully tangible, it is nevertheless a poor one. Progress should be measured in terms of changes in the target water quality criteria. This can only be done if adequate monitoring systems are employed. Enough adequate monitoring systems do not exist. Since it is basic to any program to have a reliable means of measuring progress in terms of target criteria, this deficiency is a major one. Greater emphasis on this means of performance analysis could have the very desirable effect of shifting needed attention to the greater variety of tools in addition to treatment plants which might produce more significant results more economically. According to the U. S. Council on Environmental Quality (43), "Current monitoring systems are often spotty in coverage, and do not provide the total information necessary to assess environmental conditions and trends or to predict the impact of proposed actions, or to determine the effectiveness of programs for protecting an enhancing environmental quality". FWQA and others are developing monitoring systems.

Enforce. Whatever is decided to be done, enforcement will be necessary to see that it is done efficiently. Consistent, uniform and reasonable enforcement can benefit everyone, especially those against whom enforcement is directed, because it minimizes unfair competitive disadvantages.

Distribute Costs. An important element in any pollution abatement program is the distribution of costs to the sectors of society that will bear them. In general, the more a pollution contribution can be localized to an individual, municipality or industry or other source, the more that source might be charged with the cost -- in abatement costs and in benefits foregone. Correspondingly, the more widespread the contribution, the more the public as a whole might bear the cost. However, this concept is not quite so pat as it might appear. For example, although the primary burden would seem to apply to the polluter, the user may not necessarily be completely free of bearing the costs his water quality requirements necessitate. Secondly, the principle has been well established, especially in the case of municipal polluters, that higher levels of government should bear a substantial part of the costs. The relative share of these costs is shifting somewhat, and the level at which it will eventually stabilize is hard to predict. Notwithstanding this uncertainty, cost distribution is an element that the formulators of pollution abatement programs must address. It would be very helpful to all concerned if they could depend upon a fully predictable proportioning of the costs. At present, some localities may be deferring action in the hope of shifting a great burden of costs later to higher levels of government. It would be better clearly to reward the doer than the procrastinator.

As emphasized earlier there are many external diseconomies in pollution abatement. One difficult but efficient and equitable way of distributing much of the costs is to "internalize the diseconomies" by various forms of assessments or effluent charge systems in which all polluters pay their share of the effluent collection and treatment.

Make Regional Systems Analysis. This step is placed at the end of the institutional alternatives by way of summary. Actually it embraces all of the above alternatives -- and the technical alternatives as well. Its objective is to put the pieces together to produce the best overall solution.

The word "regional" in this context requires considerable attention. If too small a bite is attempted, solutions will probably be suboptimal. On the other hand, if too large a bite is attempted the analysis can become unmanageable. As a general rule, a river basin is probably the best bite. The NAR is fortunate in this respect in that, unlike the Mississippi or other large single-river regions, it is compartmented into much more digestible bites. Its smaller rivers flow parallel into the sea. From an exclusively coastal point of view large estuaries such as Chesapeake Bay and Long Island Sound also justify a complex integrated approach. Here, however, some simplicity can be gained by recognizing that much of the water quality use conflicts can be localized in the poorly flushed subestuaries.

Some of the significant advantages of a river basin systems approach were demonstrated in a recent study of the Merrimack River by the General Accounting Office (126). Even though this study for simplicity of illustration addressed only the control of BOD and ignored most of the alternatives suggested herein, it still is useful to illustrate some of the advantages of the regional systems approach. The study showed how relatively minor expenditures could produce large improvements in water quality over a major stretch of the river. The study concluded that those actions which produce the greatest return for effort invested should be given priority attention. It questioned the efficacy of emphasizing either municipal or industrial pollution abatement categorically above the other and suggested that a general goal of bringing all plants to the secondary level might not be the most efficient solution. A thoughtful discussion of this point may be found in (18). Instead, the study showed how tertiary treatment at a few critical locations might be more rewarding than even primary treatment at others. One deficiency in the limited approach was the failure to take adequately into account the relative readiness to proceed of the different pollutant abaters. Although readiness to proceed is an important criterion, it can be given too much precedence in relation to other factors cited herein as the following quotation indicates: "An unfortunate effect of the lack of effective priorities is to channel funds away from the larger cities that include the most significant concentrations of pollution. The 'readiness to proceed' test brings applications from those communities in weak bargaining situations vis a vis State regulatory agencies. The net result is that funds have flowed in almost reverse correlation to population. And though over half of FWPCA grants have gone to metropolitan areas, they have been made available largely in the smaller suburban places rather than in the central cities." (149). Furthermore placing priority, intentionally or otherwise, on lower population areas is more expensive because it does not take advantage of potential economies of scale. Per capita construction costs of primary treatment for a sewered population of 100 may be 5 to 10 time the per capita costs for a sewered population of one million. Since coastal pollution is most significant in constricted subestuaries adjacent to major urban areas, these effects are particularly detrimental to coastal areas.

Notwithstanding the ease with which one can identify scope limitations, the General Accounting Office study did show clearly the great advantages of such systems approaches.

Selected Technical Stages. Each of the technical stages selected for representation in Table U-6 is discussed briefly below in the same order as displayed in the table.

Before Treatment. The problem of collection, treatment and disposal of waterborne wastes can often be minimized by careful attention to waste generation sources. Examples discussed below include the redesign of industrial processes, recycling, improving degradability of wastes and restricting certain uses.

Redesign Industrial Processes. The quantity and quality of waste discharges from industrial processes can sometimes be influenced by changes in the processes. Inert or harmless constituents might be substituted for harmful ones with attendant cost increases being less than the added cost of treatment. Similarly the quantity of harmful effluents might be diminished.

Recycle. Recycling is increasingly being proposed as a solution. It does provide an attractive conceptual basis for minimizing pollution at its source. However, like all single solutions, it has some important limitations which are often overlooked. Even when technically possible, recycling is justified primarily (1) when the disposed material is scarce and has a potential value which exceeds the cost of its recycling, or (2) when the disposed material can produce a significant deleterious effect on the recipient water body, or (3) when the process of disposal produces an obnoxious "litter effect". The first condition is self-policing, but it can be reinforced by research. Thus when the recovered value exceeds recovery cost, market factors will encourage the recovery. In the second instance, public action is usually necessary to "internalize the external". Otherwise, in a competitive market place, the industrial user who accepts the increased recycling cost is disadvantaged with respect to his less socially conscious competitor. The last case focuses on that type of waste which has little recovery value, which is inert or relatively harmless to the ecological environment, but which creates a social nuisance.

An example, stepping briefly into the field of solid waste, is the case of disposable bottles. The silica of which they are composed is one of the earth's most abundant materials. Except when they are dumped recklessly so as to smother an ecological resource, they are inert and have no more effect on the ecosystem than sand or rocks. Thus their offensiveness lies in their litter effect. Recycling used bottles back into the distribution system is a solution, but the individual nature of the collection and return effort might have limited effectiveness and it can impose a substantial time and monetary burden on consumer, distributor and producer alike. It might be better for them to devote far less total effort to contributing to a more adequate public collection and disposal system. The points of the illustration are (1) that recycling is far from a panacea unless certain requirements are met and (2) that the quality of life includes minimizing the complexity of daily living as well as other aspects more commonly connoted by the phrase.

Improve Degradability of Wastes. Somewhat aligned with the two previous alternatives is the idea of improving the biodegradability of the wastes. This in effect is recycling on a broad, nature-encompassing scale. Thus the use of DDT, with its very long half life, is being restricted and much research is underway to develop more rapidly degradable substitutes.

On a global basis man is probably taking a little more phosphorous out of the oceans than he is putting in. However, local concentrations of phosphorous can produce adverse effects. Thus the reduction or elimination of phosphorus from detergents is currently receiving much study because it is considered by most to be the most easily removable link in the chemicals which most influence eutrophication of lakes, rivers and estuaries. In some situations other elements such as nitrogen, carbon and oxygen can become the limiting factor. The purpose of the sodium tripolyphosphate used in most heavy detergents is to soften water. Therefore, a proposed simple but effective way of reducing the phosphate contribution of detergents, pending its complete elimination, is to reduce the phosphates in detergents marketed in soft water areas. Eighteen of the nation's 100 largest cities are in the NAR. Table U-8 shows that all of them fall into the more favorable soft-water categories. Thus, if detergents with low phosphate content were to be manufactured and distributed in a way which reflects the region's actual need, much of the regional phosporus problem might be resolved.

Improving the degradability of wastes, like all solutions, has some limitations. Thus among the most degradable of wastes are paper and the effluent of pulp mills. However, the great quantities involved -- about half the nation's solid industrial wastes by weight is paper -- and the interim obnoxious effects during the degrading process can be grossly offensive.

TABLE U-8

WATER HARDNESS IN MAJOR REGIONAL CITIES

Hardness Categories in ppm of $CaCO_3$

Soft (0-60)		Moderate (61-120)	Hard (121-180)	Very Hard (180)
Boston	New York City 1/	Patterson 2/	None	None
Springfield	Albany	Philadelphia 3/		
Worcester	Yonkers 4/	Washington		
Providence	Jersey City	Norfolk		
Hartford	Newark			
New Haven 4/	Baltimore			
Bridgeport 4/	Richmond			

1/ Minor amount is "very hard."
2/ Nearly half is "soft."
3/ Half is "hard."
4/ Minor amounts are "moderate."

SOURCE: (130)

Restrict Some Usages. Sometimes it is necessary to restrict the usage of certain products. DDT has already been mentioned. A second example prominent in the control of airborn precipitation is restrictions on the use of fuels containing a high percentage of sulphur. In these instances, the added cost to society of the restriction is deemed less than the added cost of removal or acceptance of the environmental degredation. Sometimes the incentive and priority given to research to minimize the added cost of usage restrictions can be very effective.

During Collection, Treatment and Disposal. Often the technological and economic problems of limiting wastes at their sources are sufficiently difficult as to turn attention to the next phase -- the collection, treatment and disposal of the waterborne wastes. Examples of some solutions in this phase are discussed below.

Collect from Point Sources. Where major point sources of waterborne wastes are located reasonably close together, it is usually best to interconnect these sources by sewer systems and bring the pollutants to a central point for treatment to benefit from economies of scale. Methods for evaluating this alternative on a local scale are relatively straightforward and known. On a regional scale, however, it may prove attractive to interconnect the outfalls from several adjacent communities to permit treatment at a single large plant. Similarly, depending upon each set of individual circumstances, it may or may not prove desirable to connect industrial systems with appropriate cost sharing provisions.

Collect from Non-Point Sources. Probably the poorest method of controlling non-point source pollutants is collecting and treating them centrally. Solutions at the source and in the disposal areas are more effective. As cited earlier, some of the prominent non-point source pollutants are airborne precipitates; agriculture run-off of oxygen-demanding substances, pesticides, herbicides and fertilizers; storm runoff; ground water contaminants; and resuspended pollutants previously deposited in water bodies. Some of the major, largely unsolved problems in water pollution abatement fall into these areas. At minimum, it is of fundamental importance that the quantitative and qualitative contributions of non-point source pollutants to the overall problem be determined if suboptimal solutions are to be avoided. Electrostatic precipitators, scrubbers and other means can remove some airborne precipitates as part of industrial processes. It may be that agricultural ditches, settling ponds and possibly underground filter courses could provide a useful degree of collection, but the feasibility of such methods on a large scale is currently questionable. Because of the magnitudes involved, the collection and treatment of storm runoff is especially difficult. In municipal areas, combined sewers present extraordinarily difficult problems. The great quantities of storm water almost always exceed the capacity of sewage treatment plants with the result that during storms all the effluent, domestic as well as storm runoff, must be bypassed into the water body. In rural areas, small and large reservoirs can concentrate the runoff with consequences good to downstream areas and bad to the retention basins unless treatment thereat is feasible.

Select Locations. As mentioned earlier under institutional alternatives, pollution abatement problems can be minimized by locating major sources, treatment facilities and/or outfalls at locations carefully selected to take advantage of improved assimilative characteristics of adjacent water bodies.

Select Degree of Treatment. Much of the region's attention in waterborne pollution abatement has been focused thus far on costly treatment plants for the control of that portion of the pollutants which can be classified as point source. Indeed when the many other solutions suggested herein are found infeasible, treatment plants are the only alternative.

Primary treatment involves the removal of settleable solids through processes such as screening, shredding, flotation and sedimentation. It can remove little of the colloidal and dissolved matter, but it does remove about 30-40% of the BOD. Intermediate treatments can remove an additional substantial percentage of colloidal matter but little dissolved material. It removes up to 75% of the BOD. Secondary treatment uses biological and biochemical processes to stabilize, oxidize and nitrify the unstable organic matter present in the remaining effluent. The many processes include trickling filtration, contact stabilization, activated sludge and extended aeration. Secondary treatment removes about 80 to 95% of BOD, with 85% often being used as a general planning yardstick. Advanced waste treatment (AWT), sometimes called "tertiary treatment", selectively uses currently uncommon biological treatment and physical-chemical separation processes separately and in combination to remove organic and inorganic contaminants that resist present day conventional treatment processes. It is possible, but not necessarily advisable, to purify effluents even to the extend they can be drunk, but 95% is often used as a general planning yardstick for AWT.

Since costs increase precipitously with the degree of treatment, it is important to use all of the applicable non-treatment alternatives to minimize these costs. On a regional basis, if attention is fixed on improving the water quality to meet established uses, it may mean that some sources, such as industrial sites, should receive AWT, while others such as low density rural communities may not justify any treatment at all. As mentioned earlier, goals such as the attainment of a given degree of treatment everywhere may be false ones, because they can allocate heavy costs for treatment facilities with little potential effect on water quality. Such goals thus deny the additional funds needed for adequate facilities where concentrated attention can produce the best overall water quality improvement.

At Disposal Area. The previously discussed control of pollution at its source and its collection, treatment and disposal must be considered in conjunction with the many solutions available at the disposal area itself. The set of disposal area solutions includes the retention of effluent, low flow augmentation, improved flushing characteristics, in-situ aeration, removing or coating bottom sediments and minimizing the remaining effects.

Retain Effluent. In special instances the effluent might be retained. Thus large underwater expandable bladders have been suggested as a possible means of retaining storm runoff from combined sewers for later cycling through adjacent treatment plants. The large scale requirements of this solution are potentially major drawbacks. For concentrated effluents, settling ponds are possible. Thus an industrial plant might retain heavy metals for later extraction or removal to more desirable disposal areas.

Augment Low Flow. Under this approach, water is retained upstream for release during periods of low flow to improve the dilution capacity of receiving waters during these critical periods. Low flow augmentation will substantially reduce high treatment costs to the extent that these costs are incurred meeting peak waste load requirements at low flow. However, this technique is more applicable inland than along the coast where the added dilution would be relatively insignificant.

Improve Flushing Characteristics. As previously emphasized, coastal pollution problems tend to peak in poorly flushed urban estuaries. The influence of flushing is noticeable even in non-urban areas. Thus a decrease in flushing reportedly has led to an increase in pollution in the main harbor at Martha's Vineyard. In some urban estuaries, after careful model studies, it should be possible to increase natural flushing action by improving the hydraulic cross section and thereby reinforcing desirable tidal effects.

Improved flushing in some instances can greatly minimize the cost of extensive treatment and has the further advantage of addressing non-point source pollutants which many alternative methods ignore. Three of many possible examples are cited: A second entrance to San Diego harbor is being evaluated as a means to increase the natural flushing rate. At Savannah, a possibility is being studied to use several adjacent channels and islands in such a way as to increase net tidal movement seaward. Of course all such proposals must undergo vigorous evaluation to insure that secondary effects are known and considered. The construction of dikes off Coney Island and Staten Island has been considered as a possible means of delaying the movement of pollutants originating in the New York Harbor area to a degree that they will be substantially oxidized by the time they reach the bathing beaches behind the dikes (137). Improving or retarding flushing, whichever is preferred, is possibly the most feasible solution for controlling the fresh-salt water salinity gradients so important to some species of marine life and to agricultural and ground water uses near the coast.

Aerate In-situ. Potentially in-situ aeration has the capability of minimizing oxygen deficiencies and accelerating the stabilization of BOD wastes. Like flushing and all the other disposal area techniques, it is as applicable to non-point source pollutants as it is to point source pollutants. Much research is currently underway to improve the process. One major disadvantage it shares with many other solutions is its inability to combat non-oxygen demanding wastes.

Remove Bottom Sediments. The poorly flushed urban sub-estuary where most of the pollution problem is focused is also the locale where navigation dredging requirements are most likely. Other uses besides navigation are responsible for the concentration of bottom wastes in these sensitive places. However, during the process of dredging an opportunity is presented to move these wastes to more desirable locations. The added cost of acquiring preferred disposal sites and transporting the wastes thereto might properly be charged against waste disposal. During the processes of picking up and disposing of these wastes, some oxygen-demanding wastes, previously covered up, are reexposed to the water column and can create local, temporary oxygen deficiencies. One report concluded that in the very highly polluted Arthur Kill - Kill Van Kull area between Staten Island and New Jersey dissolved oxygen was reduced 16-83% below normal during dredging in the immediate area. The persistance of residual effects was not reported (15). In some locations resuspension of pollutants may not be much more significant than the periodic churning up of bottom sediments by storms. The shallower parts of upper Chesapeake Bay are examples (111). In these instances, it is likely that the local marine life have adjusted to this recurring event. In other places, however, the temporary, localized oxygen deficiency can exceed the normal natural background range. These deleterious effects can be accepted or they can be minimized by selecting the best time for dredging and possibly by localized mechanical aeration during and after the dredging.

Coat Bottom Sediments. Where the bottom currents are relatively quiet, it has been proposed that the bottom sediments be covered with sand or a membrane to cut off oxygen-demanding sediments from the water column (166). This alternative would probably be very expensive and much research on its feasibility and environmental acceptability will be required before it can be given serious consideration in coastal waters.

Minimize Remaining Effects. Where other means fail, deleterious effects in disposal areas can sometimes be minimized, neutralized or reversed. Thus, to a degree some pollutants can be considered as nutrients. Their controlled application to selected wetlands might possibly improve desirable biological productivity. Ocean outfalls are often the sites of the best fishing. Despite more primary control efforts, some oil spills will occur and improved methods of containing, neutralizing and removing the oil are badly needed. Contingency plans for the prevention, containment and cleanup of oil and hazardous materials have been developed through cooperative Federal-state-local-private committees on a local basis.

Costs of the Solutions. Since all of the solutions are highly site-specific, it is not practical to assign specific costs to each. A few generalizations can be made, however, to provide a rough ranking of these costs.

Direct costs of the various solutions vary greatly. The institutional alternatives are for the most part relatively inexpensive when compared with the technical alternatives, perhaps in the order of 2-5%. The major institutional cost is time, because it will require a substantial amount of time to make the regional systems analyses suggested. The problem of time can be reduced somewhat by running the analyses simultaneously with some of the less costly more obvious technical solutions and accepting the inevitability of some resulting inefficiencies as a justifiable price for maintaining pollution abatement momentum.

Of the technical alternatives suggested, undoubtedly the most costly are treatment plants and sewerage systems. Costs here run high. As mentioned earlier, the plan of the Interstate Sanitation Commission in the Greater New York area, for example, envisions the expenditure of over $6.4 billion by the year 2000. Essentially all of the ISC program is for coastal water quality improvement. On a larger scale, not distinguishing between coastal and inland requirements, Appendix L (Water Quality and Pollution) estimates a total water pollution abatement cost (capital cost and all allowances for interest operation and maintenance) in the $50 billion - $100 billion range by the year 2020.

The indirect costs of waterborne pollution abatement are even more elusive. They could rival the direct costs. They include the increased cost of products and services stemming from the imposition of controls such as those spelled out in regulations or implied by public opinion.

Benefits of the Solutions. Using the example of the New York Metropolitan area, it has been suggested earlier under "Parties Affected" who will benefit principally from water quality improvements. The principal direct benefits will accure to fisherman and those seeking recreation. Those who would bathe in currently polluted waters if the pollution were abated will benefit at most about 90 days a year during the summer season. Fishermen, both commercial and sports, will benefit all year round with some peaking in the summer season. The greatest overall benefits may be more elusive and concentrated primarily in the general desire of the populace for a cleaner environment even well beyond the sensory perception of all but a very few. The existence and measure of this very important benefit can be demonstrated by a very real and long accepted yardstick -- the willingness of an informed society to pay for it.

Organizational Considerations. A variety of institutions are active in waterborne pollution abatement at all levels.

The key Federal agency is the new Environmental Protection Agency (EPA) which combines the pollution abatement responsibilities of a number of agencies. The most prominent of them are: (1) The Federal Water Quality Administration (FWQA) for water pollution, (2) The National Air Pollution Control Administration (NAPC) for air pollution, and (3) The Bureau of Solid Waste Management (BSWM) for solid wastes pollution. The Federal-state system for establishing and approving water quality uses and criteria was described earlier. FWQA also provides substantial funds to states and municipalities for implementing approved programs. So far, however, these funds have been relatively small considering the great magnitude of the program being developed for treatment plants. The Army Corps of Engineers also has an important role in its administration of the River and Harbor Act of 1899 (commonly, the Refuse Act) (129). However, the Corps' most important coastal pollution role is in the field of solid waste disposal at sea, a role which is discussed in another problem analysis (Solid Waste Disposal). For a compilation of the laws of the United States relating to water pollution control and environmental quality, see (127).

The systems analyses proposed herein will require a substantial development of the regional level of attention especially for the larger, interstate river basins and coastal estuaries. The New England Interstate Water Pollution Control Commission, the New England River Basins Commission and The Delaware River Basin Commission are all very important in this effort. However, the regional systems envisioned herein generally focus on the smaller, more integrated subsystems of the large institutions just cited. Examples are the Merrimack, Connecticut and Potomac. On an intermediate scale, the Interstate Sanitation Commission appears to have a desirable geographic span of control provided considerable liaison is maintained with authorities on tributary rivers.

The state and community levels of government are the operators.

Consistent with national guidelines and regional concepts discussed earlier, they formulate, implement, and administer programs. They and the people they tax and represent also pay most of the direct and indirect costs and reap most of the benefits. They require considerable financial and technical support from higher levels.

Individuals and industries are heavily involved in pollution abatement. Industries must respond--often at great cost--to the laws, regulations and other expressions of public opinion which together define the terms within which industry may operate. One of the major unfinished tasks in the overall program is to find better ways to fit the incentives of the market place to the abatement of pollution problems. On the individual level, people are becoming increasingly aware of how their actions can contribute to the overall environmental betterment.

Solution Effectiveness. First consider national efficiency. A National goal of achieving approved water quality levels has been established. Repeatedly throughout this analysis, ways have been suggested to reaching these levels at lower cost. In general, this can be achieved best through systematic analyses at regional levels. These analyses begin with a basic objective and a family of institutional and technical solutions. Considering the $50 billion - $100 billion expenditure currently envisioned over the next 50 years in the NAR, expenditure efficiencies produced by the proposed analyses can be very, very large.

The comments above apply in even greater measure to the attainment of regional development objectives which contemplate an upgrading of water quality beyond the currently approved standards. Costs here are about double those for national efficiency, and consequently any savings produced by regional systems analysis would be even more significant. A second major regional implication stems from the suggestion that after adequate study, new industries might be attracted to the region to take advantage of the superior dilution capacity of coastal waters in some localities. As high as abatement costs may be in the NAR, they should be substantially higher in inland areas without similar dilution capacity.

Certainly, the greatest benefit of water pollution abatement is environmental quality whether the approved standards are met or bettered. The most significant environmental benefit appears to be in the greater satisfaction people derive in knowing that they have a clean environment, even one well beyond the ability of normal perception.

THERMAL EFFECTS

Nature of the Problem. The problem of thermal effects deals with the release of waste heat to the aquatic environment especially at intensities which may cause environmental changes of one sort or another. The problem is considered here for the coastal and estuarine areas because the use of saline or brackish water for cooling can significantly reduce the fresh water supply requirements for power cooling inland.

The primary concern in the problem of thermal additions is the effect of changing the temperature regime of a water body on the living organisms within the body; in other words, the ecological consequences.

Listed here are a set of generalizations pertaining to the biological effects which may be useful for the overall analysis (22).

° Organisms of all types are adapted to some degree of temperature variation which is generally finite but may change with respect to a particular stage in the organism's life cycle. The range and rate of change that is tolerated by each species are left for investigation.

° The temperature lethal to an organism is dependent upon, among other factors, the amount of dissolved oxygen in the water and the tolerance of that organism to low levels of dissolved oxygen. The dissolved oxygen level of a water body decreases as the water temperature increases. Increase in water temperature increases the dissolved oxygen requirement for normal life processes.

° Fish have been noted to select waters that are warmed by a thermal discharge rather than to avoid the warmed water consistently. The choice of the fish to stay in the warmed area is seasonal. As might be expected, they leave the heated area during the warmer months.

° Fish are able to detect a change in temperature and will usually swim away from a location that is undesirable.

° The location that a fish has resided in influences the lethal temperatures. Fish from higher latitudes have lower lethal temperatures than fish from areas nearer the equator. However, fish living nearer the equator are likely to be living in water nearer their lethal temperature limit than fish from cooler areas.

° The natural foods of non-migratory fish probably will not be affected if the fish itself is not affected. This may be a controversial point, but is a matter of deducing that organisms that live together naturally have a somewhat similar environment in their evolutionary history and consequently have similar tolerances.

o Temperature has a direct influence on the toxicity of many substances. Non-lethal concentrations of substances such as pesticides or industrial wastes can become lethal concentrations merely by increasing the water temperature a few degrees.

o Diseases of fish become more of a threat as the water temperature increases. Conditions are more favorable for disease producing organisms at higher temperatures. Therefore, a balance exists between the resistance or defensive mechanisms of the fish and the abundance or potential threat of the disease. An increase in the temperature of the water typically reduces the disease defense, although this may not invariably be the case.

Beyond the biological effects there is also the possibility of direct temperature effects which may be important in specific circumstances. For example, the effect of increased temperature on the further use of the water for cooling is obvious. On-site uses of the water may also be affected, but frequently in a beneficial way.

Major Causes. Waste heat is generated in many industrial processes. By far the overriding producer of waste heat which is disposed of in water bodies, however, is the generation of electricity to meet the power demands of our large and affluent society. (Other sources are so minor in comparison that they will not be considered here.)

The steam-electric system is the major source of electricity produced in the NAR. Unfortunately, the maximum efficiency of today's steam-electric plant is about 42% and the average efficiency is about 33%. This means that, of every three BTU's of fuel input, one is turned into electricity and two are rejected as waste heat.

To give the reader an indication of the amount of heat rejected, a typical nuclear plant of 500 megawatt capacity designed for a cooling water temperature increase of 12.5°F would use and discharge about 35 million gallons of cooling water per hour.

Maximum plant capacities have doubled since 1960, up to more than 1100 megawatts. Increases to 2500 megawatts are projected by 1980. Where these new plants are located, vast quantities of heat will be released (Appendix P - Power).

A nuclear plant today discharges about 50% more heat to a water body than a comparable sized fossil fueled plant because the reactors must be operated at lower temperatures (lower efficiency) and because no heat is lost through a stack as is the case with a fossil fueled plant. However, as nuclear technology advances this difference will diminish or disappear.

Location. Power production in the North Atlantic Region is presently located in conjunction with population centers where the major power demands exist. Up to the present time, power plants have been located where supplies of fresh cooling water were available. As inland waters come under more strict regulations and standards, there is a tendency for new plants to be located in coastal areas, where there are large supplies of water suitable for cooling.

The major concerns for thermal effects in the coastal zone are in the more southern areas of the NAR. In these warmer waters marine organisms may be living nearer the top of their allowable temperature range and, consequently, may be more affected by temperature rises.

The problem is also of greater concern in partially enclosed bays and estuaries, where the movement of water and consequent mixing and flushing are more restricted, and where the ecological communities associated with wetlands tend to be affected by temperature changes.

Therefore, the extremes of the range would appear to be the upper Chesapeake Bay area on the high end of possible thermal consequences to the eastern portion of Maine on the low end. Figure U-9 is a map of the NAR depicting the location of all nuclear plants either in operation or under application at this time. Of the eighteen sites indicated on Figure U-9, thirteen are coastal or estuarine. None of these thirteen have, at this time, any provisions for artificial cooling.

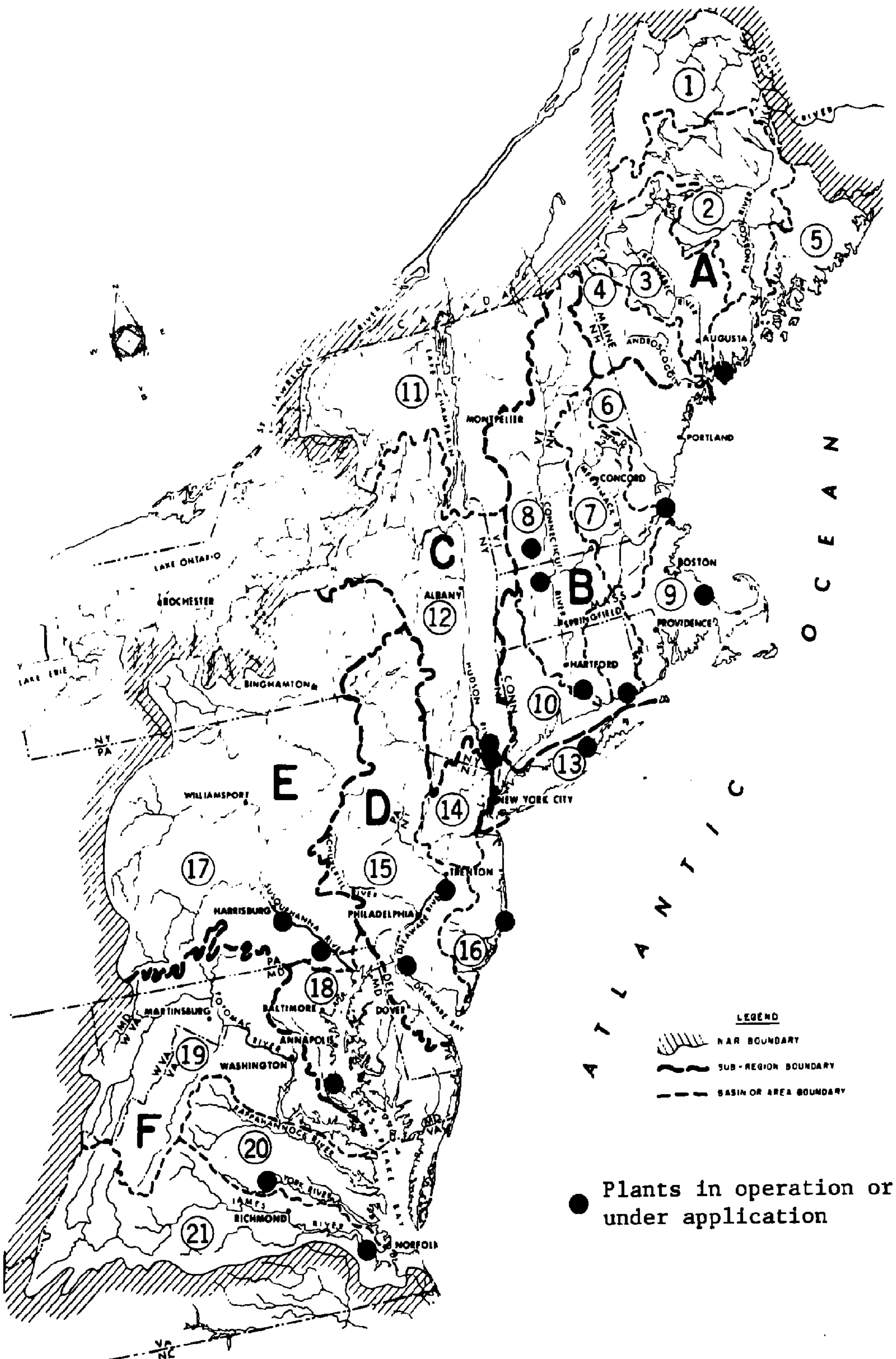
Time Characteristics. On a seasonal basis, the greatest potential ecological effects would occur in the summer months when the ambient water temperatures will be closer to the upper limit for some marine species. However, from the point of view of physical effects, the outstanding effects will occur in the winter months when the heat can be used for a number of beneficial activities.

Therefore, the problem tends to be aggravated by the seasonal nature of temperature changes. When it has the least value from a constructive view of beneficial uses, it also has the greatest potential for adverse ecological effects.

On a trend basis, the problem of thermal effects is directly linked to the demand for electricity and the technology of power production.

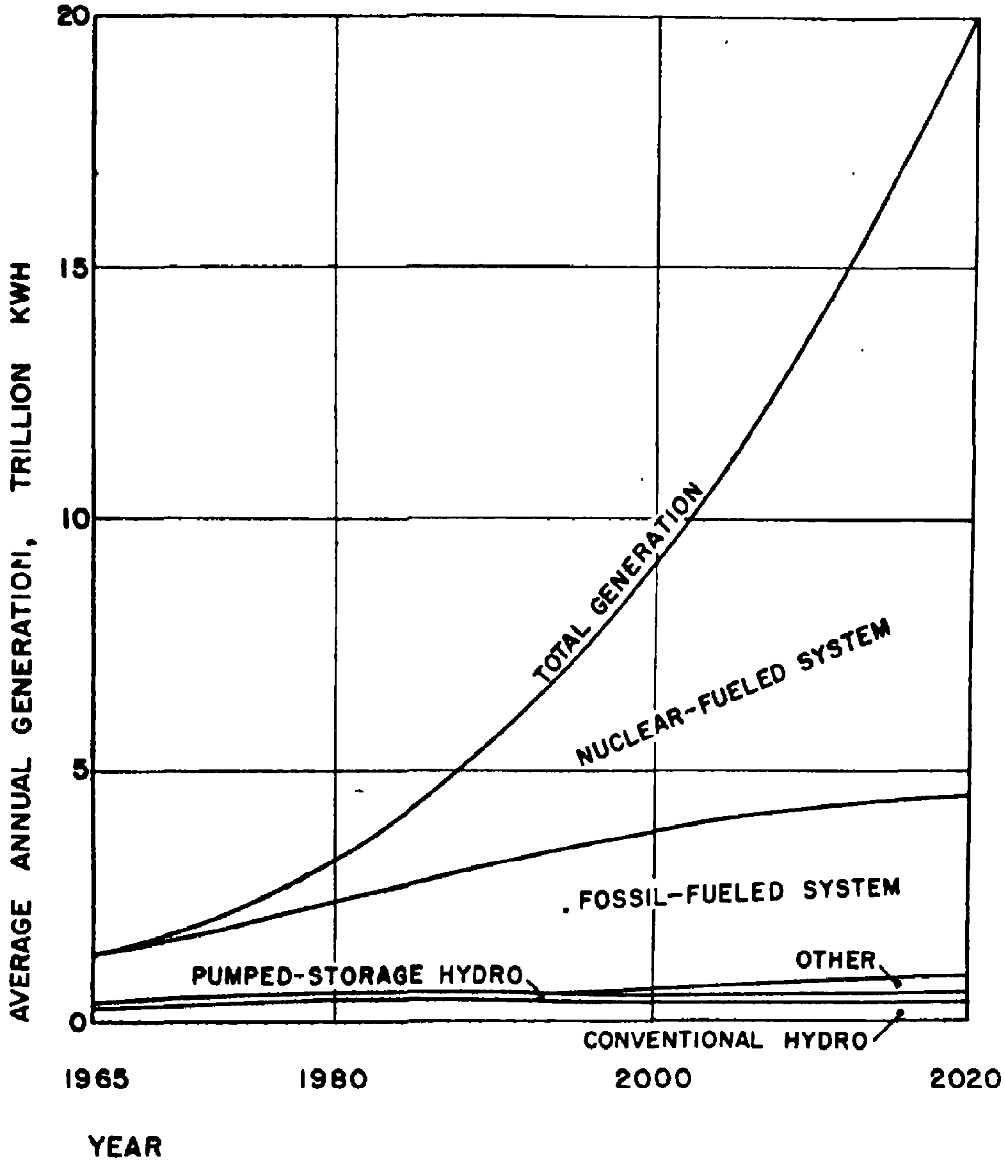
Power generation has on the average doubled every ten years since 1945, and this phenomenal rate of growth is expected to continue well into the future. Figure U-10 depicts the projected electric generation out to 2020 on a national basis. The NAR will have a proportional growth in demand (see Appendix P-Power).

Present trends in technology and economics favor an increase in the size of generating plants. This will tend to concentrate more waste heat in specific locations.



NUCLEAR POWER PLANTS IN THE NORTH ATLANTIC REGION

FIGURE U- 9



PROJECTED ELECTRIC GENERATION BY TYPES

OF PRIME MOVER

(Continental United States)

SOURCE: (97) FIGURE U-10

Parties Affected. The assessment of effects caused by thermal additions is very complex and poorly understood at this time. There is partially due to the lack of scientific agreement on what the effects really are, and partially due to the viewpoint of the assessor.

Basically, thermal effects are physical, chemical or biological. There is, however, a complicating factor in that there are also synergisms, where it is difficult or impossible to isolate the temperature factors from other factors. For example, temperature will affect the amount of dissolved oxygen in the water. Our concern here is for how such effects influence human activities.

Where the species composition of a marine ecosystem are changed because of thermal additions, the activities related to fishing may be affected by the disappearance of resident species and the appearance of species not usually found in an area. It is dangerous to generalize, but the frequently cited cases tend to indicate a disappearance of the cold water species commonly considered valuable for sport fishing and the appearance of less desirable species. It has also been observed, however, that the length of the season with good fishing is often extended in the vicinity of a temperature outfall.

There is also the very real possibility that less obvious ecological changes may not be observable for several generations of an organism, but that they may significantly affect local populations and, hence fishing activity. Other activities which may be affected by thermal additions include on-site uses such as swimming and other water-contact sports and the extension of the ice-free season in coastal shipping lanes. Generally, the effects will be looked upon as beneficial.

The effects on other withdrawal uses is not so easily determined or assessed. Where the use of water in industrial processes requires heating, a benefit will occur. Where it will be used for cooling, the thermal additions will be detrimental.

The reader will note that this analysis has skirted the issue of whether these ecological changes are "good" or "bad." The basic reason for this is that there is no "one" answer within the present level of understanding.

Solutions. A number of partial solutions have been suggested to ameliorate the problem of waste heat disposal. Unfortunately the elimination of the problem itself is hardly in sight, requiring as it would the abandonment of the steam cycle.

If there is a constant in the literature, it is the almost complete absence of remarks about electrical generation on a large scale without the steam cycle. Thus, what remains is a list of six partial solutions, each of which will be discussed below.

One partial solution is increased generation efficiency. Nuclear stations are expected to increase their efficiency in two ways. One is by the advent of the high temperature gas cooled reactor which, while still using the steam cycle, will reach temperatures now used in fossil plants. The second is the liquid metal cooled fast breeder reactor. It too will employ a higher temerature. In addition, since it produces more fuel than it consumes by nuclear reactions within the core, it will lower the price of fuel. These improvements are not translated into figures by authors. The central problem will remain one of finding sufficiently cheap metals that will remain physically stable and chemically inert in the high temperature, high flux atmosphere of nuclear cores, as well as in boilers and turbines (163).

The process of topping, whereby an auxiliary power generator is interposed between the heat source and the turbine, has possibilities for a small increase in thermal efficiency.

Gas turbines, pumped storage, and hydroelectric generation are used to provide peaking power. They produce little or no waste heat and serve as reserve capacity and in some cases, hydroelectric projects provide base load energy. In conjunction with nuclear and fossil stations, they help provide the balance necessary for system operation.

A second partial solution is to use non-steam cycle generation. It should be emphasized that this represents the most advanced thinking and is the furthest from implementation. Theoretical and technical advances are required in all cases. We should note here that in addition to any time requirement should be added the present 6-1/2 year lead time established by most companies between the decision to build and the commencement of generation.

Magnetohydrodynamic (MHD) generation with gas turbine topping is thought to be very efficient (50% or 70%) but at least ten years away from central station use (97).

The fuel cell is another non-steam cycle alternative. Fuel expenses will limit its use but it may have advantages in remote locations of limited demand.

Electrogas dynamic engines are also under investigation. These are similar to MHD generators with the ions impelled through electric fields. This system demands minimal cooling water.

Direct electrical generation from fusion reaction is another non-steam alternative. It is likely to be efficient but foreseen only on the furthest time horizon.

A third partial solution is improvement in transmission and distribution technology. At the present time, transmission, distribution, and transformation losses are about 10% of total electric generation. With the advent of higher voltages and the future expansion of the 760 kilovolt line recently installed in the NAR, some improvement in transmission losses is anticipated, since energy transmission capabilities go up sharply with increased voltages and line losses per kilowatt diminish.

A fourth partial solution is to use better cooling techniques. A brief mention may be made of departures from what is economically the most efficient cooling system, once through cooling of river or sea water. This type of cooling, found adequate in many cases today, is subject to diminishing returns. It is, of course, vulnerable to protests over ecological damage. Any one river or estuary clearly has a limited cooling capacity regardless of the distance between power stations.

Inland stations can turn to cooling or spray ponds. The former have to be very large in area, the latter are more expensive. Both cause consumptive losses and need water for recharging. They also eject much water vapor into the atmosphere where small-scale climatic changes may occur in the form of fog, ice or even rain. Both are dependent on ambient temperatures, relative humidity and wind speed for their effectiveness.

Cooling towers are large and expensive structures lacking in aesthetic appeal. The wet type discharge water vapor and create consumptive losses as do spray ponds. The most expensive cooling technique is the so-called dry cooling tower where heat is discharged directly by conduction and convection (or forced draft) between pipes containing hot water and the air. The low density and specific heat of air requires a very large surface area for efficient heat discharge. However dry cooling towers infringe on the water environment to the least degree of any other arrangement.

A fifth partial solution is to increase the mixing at discharge. Hot water allowed to flow naturally into a still receiving body will stratify. If the receiving water is flowing, a plume will form. The dimensions are necessarily vague because its characteristics towards its edge approach those of the unheated stream until differences are imperceptible. This perceptible plume usually defines a rising zone. It is of advantage for the mixing zone to be as small as possible. This is done by forcing the hot water out in a jet, wherefrom it entrains colder water and mixing is rapid. Several small jets or diffusers are better than one. Aeration, the bubbling of air through stratified water, can aid the rising rate and reduce zone size. Deep (and cold) water discharge is effective. Especially good are natural wave, tidal, wind and current action of the open or exposed coastal zone. In rivers and estuaries rapid rising is a mixed blessing on occasion. If the whole river is well mixed downstream of the discharge, it can produce a thermal block to the passage of fish, especially anadromous fish.

A sixth partial solution is the movement of plant site locations to the coastal zone. There is a tendency for central generating stations to intensify their thermal discharge; that is, more heat per plant is expected to be released. A major increase in the demand for electricity is projected well into the future. There will be a severe shortage of cooling water due to limits of thermal pollution imposed upon rivers and streams. Plants located on rivers face summer shutdowns or operation at reduced power to prevent maximum allowable temperatures from being exceeded. In the New England region there is an impetus towards nuclear stations due to the cost of fuel and its transportation. It seems likely that at least in the NAR there will be a strong tendency for central generating stations to locate on the coast or in estuarine waters for many reasons:

- There is much more water there for cooling and seasonal temperature fluctuations are much less than inland.

- Rapid mixing of the thermal effluent will be aided by waves, tides, wind and current action.

- Thermal blocking will be less likely due to the larger dimensions of the receiving body. (Conceivably this will not be true on the ebb tide in a rapidly narrowing estuary, but this condition would be recognized in site selection and discharge design).

- Intake and discharge structures can be well separated and oriented in different directions. Coastal zone siting fits in with the absence of need on the part of nuclear plants for good transportation facilities. Fossil plants will probably remain tied to an urban region for the reason that they demand port or rail facilities. The aesthetics of a nuclear power station are not in disharmony with the surroundings and in some minds may be found to enhance the region. (The same cannot be said for transmission lines unless they are placed underground). The coastal zone of the NAR is never far removed from some of the biggest electrical markets in the country and the highest population densities. Remote coastal and estuarine siting satisfies the popular fear of nuclear plants in urban areas. Higher voltages in transmission lines will offset the disadvantages of a station not being surrounded by its load. Water temperatures will be less likely to fluctuate and are colder.

Multiple ownership by several utilities of one large plant, already a feature of plants in existence, will tend to locate the plant midway between load areas. Safety records may ease urban acceptance, but site shortages may still keep plants in remote regions.

Returning for a moment to ecological considerations, several considerations are pertinent. It must be clear that it is impossible to avoid ecological changes when locating a power station. A diverse ecological community will possess some organisms living near the top of their temperature range, others near the bottom. Hot water will drive out the former and enhance the growth of the latter. If the former are more valuable than the latter, damage has been done. If the opposite, value has been added. Clearly we must know a lot about the situation we want to change. We must also select which organisms we wish to preserve and understand the effects of temperature on them.

Flood, hurricane and storm damage are to be taken into consideration in the NAR and their potential for disruption or destruction evaluated. Open coast sites are more vulnerable than estuarine ones.

Estuarine locations are likely to be ecologically more vulnerable than open coasts. Flushing action, while better than in rivers, is not likely to be as pronounced in an estuary as it is on the open coast. Estuaries serve as spawning and nursery grounds for a number of biological species which may be highly sensitive to temperature changes.

In the long run there must be a limit to the number of stations that can be located in the estuaries of the NAR. Those estuaries of major concern lie in the more southerly portion of the NAR and include in particular Chesapeake Bay, Delaware Bay, Barnegat Bay, the Hudson River Estuary, Long Island Sound and Narragansett Bay.

Thus we see that estuaries have a limited capacity for absorbing heat within tolerable damage limits. In this way they exceed the capacity of rivers but do not approach that of the open sea.

The potential for storm damage in the open coast can be mitigated and the aesthetics of the coastal zone improved if a station is sited a short distance behind the beach itself and pays a small premium for longer pipes and higher pumping costs. If undersea piping is contemplated from the beginning costs would be small.

Note has been made of the mobility of fishes and their ability to avoid water that is too hot for them although young fish may be less able to do this than mature ones. This will not apply in an estuary to the same extent as at the open shore. Many organisms are tied to the estuary because of its unique combination of conditions. While they are still free to move within it, they are unable to leave it except to their detriment, even if it does become warmer.

Finally one cannot adequately treat the problem of thermal effects without considering productive uses. A severe limitation on the use of waste heat is the fact that it is delivered in large quantities at temperatures only 20°F to 30°F above ambient. Most processes require a larger temperature differential. Seasonal requirements also limit heat application and even aggravate the problem slightly because, if maximum receiving water temperature is approached, there is no place to which the heat may be discharged. However, there are several possibilities related to the coastal zone:

- Ice Free Shipping Lanes - The navigation season in northern rivers could be extended.

- The recreation season may be extended and, with suitable enclosures, might become year around. In New England this would be of special appeal.

- Aquaculture or sea farming (117).

It has been noted that fishermen frequent the vicinity of heated water discharges and that fish, except in the two hot summer months of July and August, tend towards such areas and may even fail to migrate southwards in the winter. When caught they appear large and healthy. It appears that within the temperature rises now experienced fish have a longer and more intense growing season. This appears to be due to the increased food production of the lower chain, increased activity on the part of the fish themselves, increased aeration due to lack of ice cover in winter and increased rate of sedimentation. It is clear we have an opportunity for economic utilization of waste heat. Aquaculture is equivalent to a southward move for whatever organism is to be harvested. Several commercial species are living in New England near their northern limits and spend a portion of the year growing only slowly. Warmed water can increase the yield significantly. Under controlled conditions it is possible to increase the rates of reproductive cycles and the rate of successful reproduction. The Long Island Oyster Company, for example, has been experimenting with oyster culture rafts in heated thermal effluent and has been attempting to culture new faster growing strains for increased productivity. A further aspect is that aquaculture offers the opportunities for more than one waste product to be utilized.

A brief mention should be made of the possibilities for waste heat utilization that lie on a further time horizon. One is the location of power stations on the continental shelf under the sea several miles from shore. A research contract has been awarded to the Electric Boat Division of General Dynamics for initial investigation. Some immediate advantages present themselves; safety of the station from weather, safety of the population in the case of an accident, increased and more stable efficiency with the lower and more constant outlet temperature, and a vast heat sink occupying almost the whole part of a hemisphere above the station. Disadvantages would be the unknown effect of the upwelling of thermal currents from below, and the difficulty of service and power transmission.

Lastly, mention must be made of the possibility of the power station being integrated with the culture. It seems likely that, by cutting its thermal efficiency somewhat and by raising the final temperature of its exhaust steam, the station might have a more saleable product, for heating, industrial processes, waste treatment, and other purposes. If an integrated community were formed with the power station as its energy nucleus, a mix of power consuming customers might be formed, some using steam, others using electricity. If satellite towns are built, this possibility should be investigated. However, it seems likely that there will still be a shortage of low power, non-seasonal consumers.

SOLID WASTE DISPOSAL

Nature of the Problem. For the purpose of this discussion, "solid wastes" include those waste materials which are collected and transported to disposal sites in solid or containerized form. Solid wastes dumpted at sea include dredged spoil, sewage sludge, demolition debris, industrial chemicals and solids, incinerator residue, and floating timbers. Another form of solid wastes, garbage, is not now being dumped at sea, but means of processing it for ocean disposal have been proposed.

Offshore waters provide an alternative location to inland areas for disposing of the high volume of solid wastes generated in major urban areas near the coast. Offshore disposal could conceivably eliminate the need for reserving interior land for dumping sites for municipal refuse. Conventional means of solid waste disposal are no longer adequate for meeting projected needs. Large tracts necessary for landfill operations are increasingly difficult to obtain close by urban centers because of land costs and increasing opposition to the filling of wetlands and marshes. Emissions from conventional incinerators are a significant form of air pollution. Ocean disposal is not planned for high level radioactive wastes, the concentrated by-products from the reprocessing of used fuel elements for nuclear reactors. Current technology developed by A.E.C. indicates disposal at selected sites such as abandoned salt mines that are impervious to water and geologically stable. (Appendix P - Power.)

The problems related to solid waste disposal in the coastal zone primarily concern (1) the indiscriminate use of coastal waters for waste disposal in light of inadequate knowlege of the effects on the coastal environment, and (2) the possible expansion of offshore dumping to include the disposal of processed municipal wastes. The possible use of coastal waters for disposing of processed municipal refuse could greatly increase the total volume and tonnage in the future.

It should be pointed out that very little is known about the effects of offshore solid waste disposal. The effects of current offshore disposal activities in the New York Bight have only recently come under investigation by several Federal agencies. After investigating waste solids dumping in the New York Bight, Gross noted that no data is available to compare present conditions with those before disposal began. The National Oceanographic Data Center has begun a pilot study to collect available oceanographic data that might be useful in selecting sites for ocean disposal of solid wastes (110).

Major Causes. Among the principal waste solids dumped at sea are those bulk wastes that cannot feasibly be disposed of elsewhere under present economic constraints. Mud dredged from harbors and navigation channels is currently barged to selected disposal sites at sea in the absence of reasonable alternatives. Sewage sludge is another bulk waste which is unsuitable for landfill because of its composition and high organic content. Industrial wastes including chemicals, acids, caustics, cleaners, sludges, waste liquors, and oily wastes are barged to designated disposal sites at sea.

A recently completed national inventory of ocean waste disposal activity providing a breakdown of wastes by volume and cost on the Atlantic coast is summarized in Table U-9. Of the 23.9 million tons barged to sea in 1968, dredging spoils accounted for over 60% of the tonnage, sewage sludge comprised about 19%, and bulk industrial wastes made up about 13%. It is likely that most of these wastes originated in the North Atlantic Region. According to Gross, the New York metropolitan region dumped 9.6 million tons of solid wastes at sea in 1968 (45), this would be about 40% of the total for the Atlantic coast.

TABLE U-9

WASTES BARGED TO SEA OFF ATLANTIC COAST IN 1968

Wastes 1/	Tons (millions)	Cost ($ million)
Dredging spoils	15.81	$ 8.61
Industrial wastes (chemicals, acids, caustics, cleaners, sludges, waste liquors, oily wastes, etc.)		
Bulk	3.01	5.41
Containerized	0.002	0.017
Sewage sludge (wet)	4.48 2/	4.43
Construction and demolition debris	0.57	.43
TOTALS	23.87	$18.90

1/ Does not include outdated munitions.

2/ Includes 0.2 million tons of fly ash.

SOURCE: (17)

The deterioration and drifting timber of abandoned piers and wharves along some major ports and harbors pose a threat to navigation and an unsightly nuisance of sufficient magnitude to warrant attention. A stop gap solution is to collect the debris from the water and along the shore. A more permanent solution is the removal of the source, the deteriorated waterfront structures. Disposal involves shedding and chipping.

Location. Most of the sources of solid wastes now disposed of at sea concentrate in and around major ports and coastal cities. Offshore dumping grounds have been designated for specific waste materials in areas of predefined boundaries near coastal metropolitan areas of the North Atlantic Region.

Time Characteristics. The trend in the near future indicates that the amount of waste solids dumped at sea will increase. In the New York metropolitan area dumpings over the period 1960-1968 increased at an annual rate of 4%. Should municipal refuse be processed in an acceptable form for ocean disposal, the dumping could increase significantly.

Parties Affected. People can be affected by the solid waste disposal problem economically and in other environmental ways.

The parties affected economically are of two principle types -- those who must pay the cost of sold waste disposal and those whose economic livelihood is affected by the disposal operation without commensurate compensation. The residents of all municipalities pay heavily to dispose of their solid wastes. In the New York metropolitan region, the Tri-state Transporation has estimated (122) the capital costs at $0.4 billion for collection and $1.5 billion for disposal for the period 1963-1985. During the same period, annual operating costs are expected to rise from $180 million to $360 million for collection and from $47 million to $140 million for disposal. Considering the magnitude of these costs, it is easy to see why costs must be considered carefully in any weighing of alternative disposal methods.

People can also be affected by the solid waste disposal problem if their economic livelihood is adversely affected without commensurate compensation. Some claim that the commercial fisherman is adversely (or beneficially) affected by the ecological consequences of sea disposal, but until these consequences become known, firm conclusions can not be reached.

The principal environmental effect inland is aesthetic. To those within sight or hearing or dust range, the aesthetic impact is direct. Indirect aesthetic impacts are also important. For example, many suburban communities react unfavorably to any idea of locating "a garbage dump" within their borders, no matter how skillfully it may be hidden and operated.

Few are affected aesthetically by sea disposal. The environmental concern here is over inadequately known ecological consequences.

Solutions. Among the alternative means proposed for disposing of solid wastes, several would use the ocean bottom as the ultimate repository and some would use the assimilative capacity of the ocean to dilute and decompose certain wastes. In some instances the waste material would be processed to render them less objectionable.

Incineration of rubbish and garbage reduces the volume and eliminates biological organisms. The major objections to incineration are the emission of air pollutants and the cost of air pollution control devices. Experimental high temperature incineration (2600° - 3200°F) would reduce all forms of rubbish and garbage to a molten state and discharge an inert slag. However current cost estimates show high-temperature incineration not to be competitive for the near future (51).

Another possible solution involves compacting, baling, and carting refuse. Experiments have shown that compacted bales of refuse could be made negatively buoyant and remain on the ocean bottom. Sites would have to be selected at sufficient depth where wave action and currents would not cause the bales to shift or drift.

Certain materials such as dredging spoils and sewage sludge may continue to be directly discharged into the ocean, because they are unsuitable for landfill. Dredging spoils removed from navigational channels can contain toxic chemicals and heavy metals, and concentrations of plant nutrients among the river sediments. Undigested sewage sludge may also be highly eutrophic and also a health hazard because of its content of microbes and pathogens. A requirement that all sludge be digested before dumping at sea adds appreciably to the cost of disposal.

Even though ocean dumping minimizes difficult problems of inland disposal, the use of the ocean as a final depository for solid wastes is apparently becoming less acceptable as the oceans begin to take on the aspect of a manageable resource.

A recent study of the economic aspects of offshore solid waste disposal appraised the principal market costs of several disposal alternatives for the New York metropolitan area (51). The study cautioned that the main non-market economic variable, the effect of solid waste disposal on marine ecology, could not be incorporated into the evaluation because these effects were largely unknown.

Table U-10 taken from this study indicates the relative 1970 unit costs of disposal for the New York area, assuming close-in sites are available. The costs were calculated in terms of present value with no inflation factor added, and are based on a 20-year life cycle.

As the table indicates, the study concluded that for inland cities, the rail haul-sanitary landfall method is decidedly more economical than any sea-based method. For the coastal city, dumping of compacted bales is a little less expensive (56¢/ton or 8%) than the sanitary landfill alternative.

Environmental factors probably should govern. It is easy to think of valid environmental objections to every alternative, but at lease one must be chosen. As has been seen, most inland communities react strongly against disposal in their vicinity, primarily for aesthetic reasons. Offshore the objection is ecological uncertainty.

TABLE U-10

UNIT COST OF VARIOUS DISPOSAL METHODS

Methods	Cost in $/tons for interest rate i	
	i=5%	i=8%
Land-based		
Rail haul--sanitary landfill 1/	$ 7.34	$ 7.62
Incineration 2/	10.50	11.00
Sea-based		
Dumping of compacted bales		
Coastal city 3/	6.78	7.09
City 50 miles inland 4/	10.61	11.02
City 100 miles inland 4/	10.97	11.37
City 150 miles inland 4/	11.42	11.82
Incineration at sea		
Inland incinerator - sea dump	11.46	11.96
Water-borne incinerator	10.89	12.00

1/ Based on 50-mile railhaul. (For derivations, see Appendix of the Source.)
2/ Includes pollution control equipment sufficient to meet present federal standards.
3/ Based on Westchester to Hudson Canyon; baling but no packaging, 80-mile ocean tow.
4/ Baling at inland city, railhaul to coast and 80-mile ocean tow.

SOURCE: (51)

For sometime the need to review offshore solid waste disposal procedures and management has been recognized. Among those who have been studying the problem are the Smithsonian Institution, the U.S. Army Corps of Engineers, the U.S. Department of the Interior, the Council on Environmental Quality, the National Oceanographic Data Center of the National Oceanic and Atmospheric Agency, the Bureau of Solid Waste Management of the Environmental Protection Agency, and several academic institutions.

Some feel that no dumping should occur at all until the environmental effects are known. Others are of the view that concentrating wastes in designated areas preserves other areas intact. A third view holds that wide dispersion of certain wastes, such as organic matter, could minimize overall adverse effects and produce some benefits by increasing biological productivity. Whatever the conclusion, tentative or final, significant monitoring of the major ocean disposal sites should be required.

A comprehensive review of ocean dumping and recommendations of policy and regulatory legislation is presented in a recent report prepared by the Council of Environmental Quality (32). The report recommended "a comprehensive national policy on ocean dumping of wastes to ban unregulated ocean dumping of all materials and strictly limit ocean disposal of any materials harmful to the environment".

RECREATION

Nature of the Problem. The problem considered here is how to improve the usefulness of the region's coastal zone in satisfying current and forseeable recreational needs.

Recreation, as considered here, includes all coastal land and water resources, human activities, and development that serve to provide for the portion of leisure time which is spent out-of-doors along the maritime edge of the North Atlantic Region. The people who choose to spend a portion of their free non-working hours engaged in refreshing diversions along the coast are considered here, be they active pursuits such as surfing or sailboating, or passive amusements such as beachcombing or photographing shore birds. The land and water resources, man-made facilities, vacation homes, marinas, waterways and piers that provide the resource base for recreational pursuits are included.

Outdoor recreation in coastal areas includes:

- Water contact activities such as swimming, surfing, water skiing and skin-diving. The resource base is essentially the sandy beachfront and surf.

- Boating with cabin cruisers, motor boats, sailboats, submersibles and rowboats. The resource base is primarily protected waterways and water surfaces.

- Sportsfishing from boats, piers or the shoreline. The resource base is primarily the fish, wetlands and shoal water habitats.

- Hunting, primarily water fowl. The resource base is essentially wetlands.

- Passive recreational pursuits including pleasure driving, viewing, sunbathing, beachcombing, photography, walking, birdwatching and nature study. The resource base is essentially the more scenic natural areas of the coast.

Major Causes. The major causes of the problem are high demand, limited supply and use conflicts.

Nationally, the value of the coastal zone for recreational use has been estimated as second only to marine transportation. In the North Atlantic Region beaches like Jones Beach, Coney Island, Atlantic City and Ocean City, Maryland each regularly accommodate 10-20 million visitors annually. In 1965 there were nearly three million saltwater fin fishermen in this region. They spend about $200 million as part of their hobby. Private recreational land values have appreciated rapidly along the coast. For example, on Cape Cod many plots currently selling in the $10,000 - $15,000 range sold for $150-1500 in 1956. As population, affluence, leisure, coastal accessibility and outdoor appreciation continue to expand, recreational demands will grow rapidly.

The ability of the resource base to meet this demand is limited in several important ways. Most important of all, climate limits almost all currently popular forms of outdoor coastal recreation to about 90-100 days a year in this region. The most popular form of coastal outdoor recreation, the water contact activities are based upon sandy beachfront and surf. Of the 4,700 miles of ocean fronting shorelines in the North Atlantic Region, about three-eighths (1800 miles) is beach and one-eighth (560 miles) is available for public recreation. Beaches vary greatly throughout this region: Maine with more than half the ocean shoreline has almost no beaches, the rest of New England is mixed, and from Long Island South the 400 miles of ocean shoreline are all beach. All but 15% (735 miles) of this oceanfront is privately owned. Public ownership is most prominent in Massachusetts, New York and New Jersey. The non-oceanic coastline (about 3900 miles) consists of the coasts of Narrangansett Bay the East Shore and Great South Bay on Long Island, Delaware Bay, Chesapeake Bay lesser embayments and the lagoons or backbays from Long Island South. Almost all of it (about 80%) is privately owned and very little of it (about 15%) is beach. Of course, here, too, there are numerous local departures from this regionalwide perspective. (136)

The base for boating is primarily the protected areas of estuaries and embayments and the waterways such as the Intracoastal Waterway. These areas appear ample for current and expected populations. For example, the approximately 6 million acres of protected coastal recreational boating waters in this region are equivalent to a halfacre for every family now living in the NAR. The limitation for boating is not congested water surfaces, but shoreline facilities and affluence.

The base for hunting and sportsfishing is wetlands and shoal water habitat. The 3 million acres in the NAR are equivalent to one-quarter acre per family. The limitation here does not appear to be wetland and habitat area but waterfowl abundance and hunter affluence.

The base for passive recreational pursuits is essentially the entire coastline. This is hard to quantify because tastes differ so much. For aesthetic isolation, anyone around is too much. For girlwatching at the beach, the more the merrier.

In summary, if allocated on a per-NAR-family basis, the coastal recreational resource base would be distributed something as follows:

° Four inches of public recreational oceanfront beach for all beach recreation.

° One-half acre of protected waters for all boating recreation.

° One-quarter acre of wetland and shoal water habitat for all hunting and sportsfishing.

Several use conflicts complicate the problem of satisfying recreational demand. High density recreation and low density recreation exert diametrically opposite demands on the resource base. Mosquito control programs also tug in an opposite direction from wetland recreation. Inadequately controlled waste disposal causes pollution and conflicts with several forms of coastal recreation. Management of wetlands for wildlife purposes often conflicts with their management for marine life purposes. Residential, commercial and industrial uses occupy land which might otherwise be available for public recreation.

In summary of causes -- demand for all forms of coastal recreation is rising fast; the major resource limitations are seasonality and public beachfront (for the most popular form of recreation - bathing); and a number of conflicts exist and their resolution will undoubtedly require many tradeoffs. Aside from seasonality, the shortage of conveniently accessible, developed public beach facilities near population centers is easily the most significant limitation.

Location. According to projections of accumulated unsatisfied need for outdoor recreation in Appendix M, the need will be greatest for the most heavily urbanized areas of the region. Here the need is primarily for facilities for one-day outings and weekend trips, and intensive use of the coastal recreational resource base. In the interest of improving environmental quality the need for diversity in the form and quality of recreational experiences is most acute in the urbanized coastal zone.

The more remote and inaccessible areas of the coastal zone provide a scarce recreational opportunity in the form of less intensive activities in more naturalistic surroundings. Portions of the Maine coast and some of the isolated barrier islands such as Fire Island and Assateaque Island provide such a setting.

Areas in which recreation conflicts with other coastal uses are located primarily around major ports and cities where residential and commercial use of the shorefront predominate. Water quality sufficiently low to preclude swimming and shellfishing is common near coastal cities and the estuaries of major streams where the full assimilative capacity is ued for diluting wastes. Water pollution is also becoming a problem around some recreational developments along remote coastal bays and small estuaries as a result of waste discharges from boats and private homes.

Time Characteristics. The temporal aspects of the recreational demand are particularly significant insofar as they influence the intensity of use, the types of activities and the space that must be allocated. Outings or day use generally limit the area served by a given recreational facility to the time an individual or family is willing to spend in travel. The range for day use travel has been estimated at about two hours. Using this criterion, most of the NAR shoreline is within two hours travel time of some major urban center. Another limiting factor in day use recreation at any facility is the transportation mode. With the exception of a small portion of coastline served by mass transit, most day use recreation is reached only by private automobile, and is subject to constraints of highway capacity and parking facilities. Cape Cod for instance is now served by roads much too inadequate to meet peak capacity, so that the overcrowded highways actually regulate the numbers of day use recreationists. Parking facilities, vast as they are, limit the use of Jones Beach during peak use in the summer.

Persons seeking coastal recreation for extended periods such as weekend trips, vacations, or an entire season, place added demands on the resource base for overnight accommodations such as vacation homes, cottages, campsites and motels. Extended use also expands the potential range of an area served by a given coastal recreational facility. Thus, the coast of Maine, removed as it is from population concentrations, serves day use recreation for primarily local residents, whereas vacation use attracts persons from as far as New Jersey and Pennsylvania.

As pointed out earlier, an important time-based characteristic, seasonality, is the single most important limitation on coastal recreation. It not only denies off-season use but severely limits the quality of the facilities which can economically be provided. Seasonality is easily the most significant factor in the economy and unemployment rates in coastal recreation areas.

Parties Affected. The parties most seriously affected are those persons without the means to travel to recreational facilities. Transportation seems to be the key to gaining access to coastal recreational facilities. People lacking such means are the less affluent city dwellers without a private car.

Those who are not residents or property owners are more likely to be restricted in gaining access to the coastal waters for swimming or boating. In areas where the coastline is privately owned, particularly in communities where vacation homes and seasonal homes are prevalent, the local municipality often provides public beaches and launching ramps for the use of residents only.

Solutions. To solve the problem of improving the usefulness of the region's coastal zone in satisfying current and forseeable recreational needs, one approach is to attack the principal causes -- briefly: high demand, limited supply, use conflicts.

Not too much can be done about demand. The positive way the problem is worded, we can not abnegate responsibility by approaches such as (1) let them stay home -- outdoor pools, TV's, etc., or (2) limit the population and that will reduce demand or (3) let the increasing congestion, travel inconvenience and costs establish their own limitations on demand. Instead, the problem is how to increase human enjoyment, not turn it elsewhere or supress it.

Much constructive work on demand needs to be done to understand it better, to learn of peoples' recreational appetites and the inconvenience factors and inducements which influence it. Examples: How many would become boaters if marinas were as cheap as parking garages and boats as economically attainable as rental cars today? How many would use Jones Beach and adjacent Gilgo Beach if they could drive there easily in three-quarters of an hour or less and were assured of plentiful parking, excellent facilities, no traffic jams and no excessive beach congestion? How many would engage in sports-fishing if it were inexpensive, and easily accessible and a reasonable catch could be expected? (24) and (26)

Based upon answers to questions such as these the problem of supply could be attacked. The limiting factors could be more surely identified and possibly overcome. Although it appears quite certain that almost every facet of supply must be considered in meeting coastal recreation demands near large cities, it needs to be known what improvements will provide the most return -- $X for pollution abatement, $Y for beach acquisition, $Z for extending mass transit to beach areas, $Q for better parking, or $R for better highways or more launching ramps, etc. Which of these necessary things should get budget priority is a real-life question that must always be answered.

Looking to the long range future, it would seem that there is quite an untapped capability to increase the most critically short resource -- sandy beaches, provided some diminuation in the quality of the experience can be accepted. There are several thousand miles of non-beach shorefront which could be converted to beaches by sand nourishment along almost all of the backbays and estuaries. True, the surf action and seabreezes would not be so attractive as along the ocean beaches, but the congestion would be much less.

The use conflicts listed earlier were illustrative; it is easy to think of others. One of the most important conflicts is internal to recreation -- the conflict between high and low density recreation. The concept of the greatest good for the greatest number if followed to its ultimate conclusion would completely submerge all individuality. It seems fully in accord with American traditions to slightly limit "the greatest number" so that all might have a chance to "do their thing." To preserve a spectrum of choice while giving considerable but not absolute preference to the majority is one of the key challenges to coastal zone planning and management. The spectrum is currently being preserved more through natural selection than through purposeful action. Thus, Maine provides low-density aesthetic appeal not so much because it is beautiful or because it was arranged that way, but because it is remote, has a harsh winter which discourages settlement there and because the beaches are too few and the water often too cold for family bathing.

In the future, natural screening factors such as these will be less significant. Central Park on Manhattan Island was a purposeful product of planning and action. Increasing in the future, purposeful action such as this will have to surplant the more or less fortuitous selection process to date.

MARINE TRANSPORTATION

Nature of the Problem. All forms of transportation -- air, surface, and marine -- have significant coastal implications.

Air transportation competes in some ways with marine transportation. This relationship is discussed latter in this analysis under "Solutions." As the need for more or larger airports close to urban centers mounts, coastal areas are frequently considered as likely locations for many reasons. Almost all major urban areas are close to the coast. Overwater approaches significantly reduce problems of safety and noise. Relative to inland areas, coastal landfill areas are inexpensive. Furthermore, by selecting a coastal site, a community can avoid a huge loss to their real estate tax bases. To capitalize on these advantages, large tracts of coastal wetlands important to marine life are sometimes filled in. It is difficult to weigh the net gains and losses from these conflicting use requirements. The general problem of landfill as it affects coastal wetlands is considered in another problem analysis. (See Conservation of Wetlands).

Surface transportation requires rights of way for roads and railroads. Often they are located along the coast because of certain transportational advantages there. If they are not located with environmental sensitivity, they can become aesthetic blemishes and restrict coastal access. When transportation arteries cross navigible waterways and estuaries the bridges and tunnels can restrict the expansion of marine transportation and adversely affect tidal flushing upon which marine life and waste disposal may depend. Pipelines are an alternative to coastal marine transportation in the delivery of bulk liquid products, especially petroleum.

Marine transportation is particularly a coastal consideration. From an economic point of view, it has been claimed to be the most significant use of the coastal zone. Nationally, it had an estimated value of about $11 billion in 1963 according to Figure U-3. On a slightly different basis, its value in the NAR is estimated at over $3 billion annually in Table U-11. Although marine transportation occupies only a very small part of the region's coastline, say 1-2%, this part often has special value to many other coastal uses. Alterations in the location or configuration of approach channels, protective structures and shore facilities can affect these other uses.

Since marine transportation is developed comprehensively in Appendix K (Navigation), only its major environmental and economic problems are covered herein.

On a worldwide basis, dramatic changes have occurred in ocean shipping over the last 15 years. The two most important changes are the introduction of the containership and the very deep draft bulk carrier. The NAR is doing rather well accommodating the containership despite some growing pains. However, unless this region can find acceptable ways of accommodating even a modest portion of the increase in vessel drafts for bulk carriers, it will continue to pay a transportation cost for its substantial bulk imports and exports perhaps approaching twice the cost attainable with some of the newer and proposed deep draft vessels. Currently bulk products such as petroleum, ore and coal make up about 80% of the region's overseas tonnage. This proportion can rise even higher with increasing consumption, the possible opening of an Arctic tanker route, and upward revision in the quotas which now limit the region's oil imports. If future requirements are to continue to be met by the current small tankers, environmental side effects such as congestion and oil spillage could worsen.

The scope of all analyses, including this one, must be limited to attain focus. This analysis is bounded first of all in a geographic and functional way. Within this envelope it is further bounded by the depth of treatment suitable to the broad purposes of the overall NAR study. To provide an appreciation of these limits and to establish the context within which this analysis is made, these limits are described more fully below.

This analysis focuses geographically on the regional, coastal aspects of the problem to include the approach channels, the harbors, the off-loading facilities, the adjacent shore facilities and that part of the distribution system which is carried out by coastwise shipping. Cited as important exterior influences, but not covered in detail, are the ocean traverse and the inland distribution system.

As reflected in the problem definition, the analysis focuses functionally on commercial shipping. Thus it does not cover such related aspects as recreational boating which is considered in another problem analysis (See Recreation), the status of the U.S. Merchant Marine, and related problems of shipbuilding, labor, and efficiencies potentially obtainable through improved weather prediction and port administration. Impacts, beneficial or detrimental, to other users of the coastal zone are identified and possible solutions or ameliorative measures are suggested.

Data and comments are geared primarily to the regional perspective. They are not sufficient to evaluate individual ports. For example, significant limitations on further deepening in major ports have been generally rounded herein to the nearest five-foot interval, and are intended to have an accuracy necessary only to establish the individual port's general candidacy to accommodate some of the larger vessels anticipated in the future.

Major Causes. The satisfaction of major needs in marine transportation presents problems, because of the large current and projected scale of marine transportation, increases in ship size, physical limitations of the region's coastal zone and environmental considerations.

The first major cause of the problem, the very large scale of marine transportation, is indicated by Table U-11.

TABLE U-11
COMPONENT QUANTITIES

Commodity	Volume- in million short tons,1968					Estimated Port Revenue	
	Foreign		Coast wise	Internal and Local	Total	$/Ton	Total ($ billion)
	Imports	Exports					
Petroleum:							
Crude	61	--	9	22	92	4.38	.40
Refined products	60	1	98	86	245	4.38	1.07
Other Bulk:							
Coal	--	35	12	19	66	3.02	.20
Ore	28	1	12	27	68	3.51	.24
Grain	--	4	--	1	5	7.06	.04
General Cargo & miscellaneous	28	12	27	13	80	18.46	1.25 1/
Total	177	53	158	168	556	---	3.20

1/ Computed at $1.34/ton for internal and local;and $18.46/ton for all others.

SOURCE: Tonnages are developed from information provided by the U.S. Army Corps of Engineers (138). Port revenue cost factors are based upon a study by the Maritime Administration adjusted for price escalation (1). They are estimates of direct dollar expenditures to move the cargo through the port. Their principal components are labor, port terminal income, rail and motor freight credited to the area, auxiliary services, and miscellaneous port and terminal expenditures.

Almost all of the crude oil imports come to the Delaware River ports, Portland and New York with 27, 22 and 10 million tons respectively. The refined petroleum products are imported in many locations; about half, 30 million tons, comes to the Port of New York. Essentially, all of the coal is exported from Hampton Roads. The ore imports consist primarily of iron ore in the Delaware River ports (11 million tons) and in Baltimore (10 million tons). Grain shipments are relatively minor. About half leave Hampton Roads. The major volume of general cargo imports and exports is located at New York, the Delaware River ports, and Baltimore, in that order.

One study (2) expects crude oil imports to rise about 70% from 1968 to the year 2000. At this rate the 1968 imports would easily double by 2020. Any upward change in the current import quota which limits foreign imports to 12.2% of domestic consumption, or the creation of a free port exempt from this restriction would have a major impact upon this projection. Projected increased in dry bulk imports vary widely from about 70% to about 350% by the year 2000 (2).

A second major cause of the problem is increases in ship sizes. Appendix K (Navigation) contains a detailed description of each of the four major classes of commercial ocean vessels and their varients, together with an analysis of the future growth trends for each. For reasons cited in Appendix K, little increase is expected in the sizes of passenger vessels or general cargo carriers, including both containerships and break-bulk vessels.

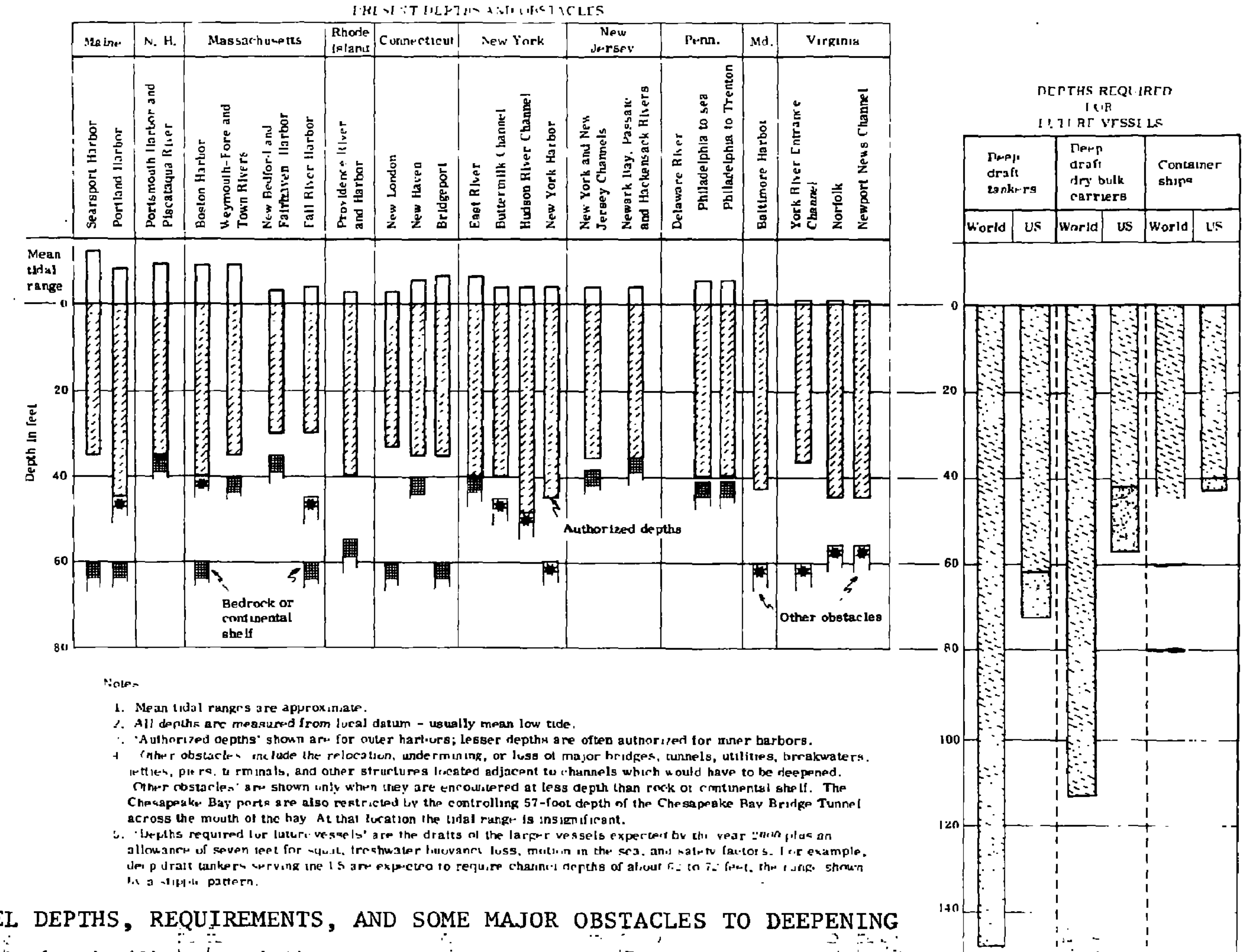
For the other two classes -- tankers and dry-bulk carriers -- major size increases are expected before the year 2000. For the longer trade runs serving the region from South America, the Middle East and Alaska, if the Northwest Passage becomes a feasible route, 200,000 deadweight ton (DWT) tankers are expected with drafts of 65 feet or more. Dry bulk carriers importing iron ore and exporting coal in the NAR are expected to reach 100,000 DWT with drafts of 45-50'. Combined ore-bulk-oil (OBO) vessels will require drafts of 60 feet or more (2).

These vessels are small compared to the forecasts of tankers five times larger and dry-bulk carriers twice as large, in terms of DWT, expected to be operating in the next 20 years elsewhere in the world (135).

A third major cause of the problem lies in the limited depths of the harbors and channels in the region. Figure U-11 illustrates the channel depth problem.

Note that none of these major existing Atlantic ports can come close to accommodating the depth requirements for the larger tankers expected to be serving the U.S. in the year 2000 without running into problems of bedrock, continental shelf or the other serious obstacles identified. Recent unit costs of about \$2 a cubic yard for "conventional" dredging and about \$20 a cubic yard for blasting and removing rock make the total cost of significant deepening by amounts in the 17-35 foot range, prohibitive.

Figure U-11 also shows that none of the major ports in the region can accommodate the full range of depths required for the expected



Notes

1. Mean tidal ranges are approximate.
2. All depths are measured from local datum - usually mean low tide.
3. 'Authorized depths' shown are for outer harbors; lesser depths are often authorized for inner harbors.
4. 'Other obstacles' include the relocation, undermining, or loss of major bridges, tunnels, utilities, breakwaters, jetties, piers, terminals, and other structures located adjacent to channels which would have to be deepened. 'Other obstacles' are shown only when they are encountered at less depth than rock or continental shelf. The Chesapeake Bay ports are also restricted by the controlling 57-foot depth of the Chesapeake Bay Bridge Tunnel across the mouth of the bay. At that location the tidal range is insignificant.
5. 'Depths required for future vessels' are the drafts of the larger vessels expected by the year 2000 plus an allowance of seven feet for squat, freshwater buoyancy loss, motion in the sea, and safety factors. For example, deep draft tankers serving the U.S. are expected to require channel depths of about 62 to 72 feet, the range shown by a stipple pattern.

CHANNEL DEPTHS, REQUIREMENTS, AND SOME MAJOR OBSTACLES TO DEEPENING

Source: (135), (2), and (90)

FIGURE U-11

dry-bulk carriers. Portland, New York and Hampton Roads can carry a few at the lower end of the requirement. All three have no obvious major bedrock or other obstacle limitations, except major costs for conventional dredging. Providence and Baltimore with deepening of 5 feet or less might also accommodate a few of these vessels at the lower end of the requirement without bedrock or other major problems. Observation of the tidal ranges discloses a possibility of bringing some larger size vessels into the port to a deepened basin during high tide, but the feasibility of this alternative would require local study. Another possibility is the LASH or SEEBEE with drafts up to about 33 feet. These vessels could offload lighter, shallow-draft barges for coastwise and inland distribution. The economic feasibility of this alternative requires considerably more study of their performance in the Gulf of Mexico where they are first to be tried.

There are no significant obstacles of depth for containerships, break-bulk cargo vessels and passenger vessels expected for the year 2000 at numerous ports in the region.

A fourth major cause of the problem lies in environmental considerations. These problems are covered at length later in this analysis under Parties Affected. They are also cited frequently throughout the analysis.

Location. By its basic nature, ocean marine transportation is dependent upon the coast. Many other users of the coastline, even recreationers, could conceivably go elsewhere. But it is impossible to conceive of moving heavy tonnages from abroad, within the time frame of this study and well beyond without marine transportation. Transoceanic pipelines for the movement of liquid products, even with some in slurry form, are conceptually possible, but their economic, environmental and perhaps technical realities are well beyond mature consideration. For the solid components of oceanic cargo, it is not even possible to conceive of an alternative except for air delivery of the low-weight, high value cargo for which time in transport becomes the dominant factor. For the ocean trade, therefore, the question is really where on the coast and how, not whether.

Conceptually, at least, more options are open for the coastwise and inland distribution systems. Here marine transportation competes with pipeline, rail and truck. To investigate the performance of the market place in allocating this trade is well beyond the scope of this study. It would take a really national transportation study to do so.

The strategic positioning of marine transportation presents some options at the supra-regional, regional and local levels.

Other regions, especially eastern Canada, the Great Lakes, the South Atlantic and Gulf are possible competitors with the NAR for marine traffic. The NAR is closer to Europe and the Arctic oil fields than any of the others except the Canadian ports. It is about equidistant with the others from the Middle East oil fields. It is closer to the South American oil and ore sources than the others except the South Atlantic and some of the Gulf port. Currently, there is talk about a "North American land bridge" between Eastern Asia and Europe. Under this concept, certain segments of the container trade, characterized by higher values ascribed to time lost in transit, might be landed in the Seattle-Vancouver area and moved across the continent in highly specialized container trains to Canadian, NAR or even Great Lakes ports for movement to Europe. Analysis of this possibility is beyond the scope of this study. Such an analysis would evaluate the type and volume of cargo which would move economically by such a system; the implications of possible new alternative routes such as the one through the Arctic or a sea level canal across Central America; and the comparative positions of the Canadian, NAR and Great Lakes ports.

The NAR has by far the largest concentration of people and industry in North America. A quarter (26%) of the people in the United States live there and they command a third (31%) of the Nation's earnings (Appendix B - Economic Base).

Several developed Canadian ports, notably Halifax, have harbors significantly deeper than those found in the NAR. However, the NAR ports are deeper than those in the South Atlantic, Gulf and Great Lakes systems (135).

As Table U-12 indicates, the value of the existing port facilities in the NAR far surpasses that in any other major port region in North America.

TABLE U-12

TOTAL NON-FEDERAL COASTAL PORT DEVELOPMENT EXPENDITURES TO DATE 1/

(Millions of Dollars)

Region	1946-1965 inclusive	1966-1970 inclusive	Total
North Atlantic	838 2/	168	1,006
South Atlantic	114	51	165
Gulf	385	65	450
Great Lakes	251	8	259
(Total U.S. Ports)	(2,127)	(520)	(2,647)
All Canadian Ports 3/	429	?	?

NOTES:

1/ These are public expenditures, e.g. New York Port Authority. An additional 75-100% was private investment. The total estimated non-Federal cost thus appears to be about $5 billion.

2/ $486 million of this was for the Port of New York.

3/ Atlantic, Great Lakes, Pacific and Arctic.

SOURCE: (4) and (102)

On balance the NAR appears to have some outstanding advantages which will cause its existing trade to remain largely within it.

Within the North Atlantic Region, probably not more than one percent of the tidal shoreline is allocated to shipping. The major port systems, in terms of gross tonnage in 1968, are shown in Table U-13.

TABLE U-13

MAJOR NORTH ATLANTIC PORT SYSTEMS 1/

Annual Gross Tonnage (Million Short tons)	Port System
232	Port of New York and Hudson River 2/
116	Delaware River: Trenton to the Sea
53	Hampton Roads
42	Baltimore
27	Portland
23	Boston
11	New Haven
10	Providence

1/ Between them these eight port systems account for all but 42 million short tons (8%) of the NAR total.

2/ 175 million short tons of this were for the Port of New York.

SOURCE: Compiled from (138).

Economies of scale are producing some shift towards fewer, larger ports, for the import/export trade. It is relatively easy to figure the volume necessary to cause a very large bulk carrier or even containership to devote the time (expense) required to make deviations from its major route. For example, Boston might have to develop significantly more volume to cause these large European-New York vessels to call at its port.

On a local basis, several transportation trends can affect the use of the coastal zone in very important ways.

One trend is toward reduced shorefront and increased storage area. Fewer but much larger ships with improved offloading capabilities require less total shorefront. The land areas behind the waterfront must accept the intermittent, sudden, large surges of cargo from incoming ships and hold them long enough to permit their economical inland movement at a relatively even rate. This requires space, much more than can often be found behind urban finger piers.

A second trend is increasing demand for urban waterfront. This demand is reflected in increased appreciation of the amenities, high and rapidly rising land values and congestion.

A combination of both of these trends is producing a migration of some of the larger port facilities to outlying areas. The most conspicuous example of this trend is Port Elizabeth, a new $750 million facility with very large land storage areas about eight miles from Manhattan. Partially as a result of such relocations, significant parts of high-value urban waterfront are now becoming available for other uses. What these other uses should be points up one of the many problems of urban and coastal-zone planning and management, cited earlier in this Appendix under "Coastal Uses." New York's "Lower Manhattan Plan" calls for filling in significant parts of the coast occupied by the obsolete finger piers and building mostly very high rise apartments on the new land thus made available (101).

Time Characteristics. Except for possibly the passenger cruise trade which tends to peak seasonally and which appears to be migrating to the South Atlantic ports, marine transportation in the NAR is relatively constant throughout the year. As has been seen, the long-range trend is for major increases in volume.

Parties Affected. Consideration of the effects on people should include both transportation users and other users of the coastal zone.

Transportation "users" are those employed in providing the services and those who ultimately pay for the services primarily through the transportation-generated cost of their purchases. The economic and non-market values of marine transportation to these users are considered below.

According to Table U-11, port revenues in the NAR are about $3-4 billion annually. Many studies have been made of the economic significance of ports (142). A 1956 study estimated the total direct and indirect impact of the Port of New York at $6.3 billion annually and 430,000 jobs. A study of Baltimore estimated the direct impact of its port at $0.6 billion annually and 62,000 jobs and its total impact at $1.6 billion and 155,000 jobs. It attributed 12% of the 1966 Maryland gross state product to this port. A study of Virginia ports concluded that 1968 port and harbor related activities directly generated 94,000 jobs and wages of $0.63 billion. Indirectly, the study concluded an additional 131,000 jobs were generated. In total, one out of every eight jobs in Virginia were directly or indirectly related to Virginia's port and harbor activities. The lack of a common base of definition and methodology makes direct comparisons misleading. The examples herein are intended solely to illustrate general orders of economic magnitude. A more rigorous disciplined portrayal is beyond the scope of this study.

The 466 million short-tons imported nationwide in 1967 had a value of about $40.7 billion. This is the value of what is moved, not the value of the services added.

A Commerce Department study (9), formulated on the implication that coastal marine transportation has an economic value added equivalent to the amount society is paying for the service, concluded that its national value in the mid-1960's was about $11 billion. This is the cost of the services charged at the sea-land interface for cargo handling. It does not include the charge for the overseas movement itself or its related components such as shipbuilding. Neither does it include the capital outlays for port improvements implying that these costs, except probably for subsidies, are imbedded in the servicing charges. The study does not provide a regional breakdown, but it would appear that the NAR's proportion of this nationwide total would be about one third or more.

For the industries and customers who ultimately pay for the transportation through their purchases of goods and services, some significant economies are implicit in predictions such as the following:

- Theoretical systems analysis has estimated containerization to have the capability of increasing port labor productivity about 20 times (118). Operational experience at the Dundalk Marine Terminal in Baltimore indicates increased efficiency over break bulk handling by a factor of about 13.

- A 110,000 DWT tanker can move a barrel of petroleum at about two-thirds the cost of a 40,000 DWT tanker (135). Since about 68% by weight of the NAR's imports is petroleum (138), the pertinence of this estimate is especially significant. A somewhat similar relationship applies to major dry bulk movements which currently make up about 16% of the imports and 75% of the exports by weight in the NAR.

In addition to their economic impacts, ports have other important impacts not readily visible in the market place. These relate to such things as national defense and international relations. Ports also influence population distribution. The larger the city the more likely it is an important port. Within the NAR are 23 of the Nation's 100 largest standard metropolitan areas (SMA's). Of the five NAR cities which rank in the first 25 nationwide, all but one (Washington) is a major ocean port. Five more NAR cities rank in the second 25 nationwide, and 3 of them are major ports and 2 are minor ports. Eight more NAR cities rank in the third 25 nationwide but only 3 are major ports, 1 is a minor port and 4 are not even on the ocean. In the fourth 25 nationwide there are 5 NAR cities. None of them are even on the ocean (140).

Ports and the activities necessary to provide and operate them, can have significant effects on other non-transportation oriented uses of the coastal zone. Keeping in mind that these effects are for the most part concentrated in the vicinity of ports, some of the interactions with other major coastal uses can be examined.

Commercial fishing can be hurt in several ways. Fishing is often restricted in port areas and shipping channels for safety and congestion reasons. No shellfishing, for example, is permitted in New York Channel.

Fishing can be affected by ship-caused pollution in harbors and by ship-caused oil spills. Some aspects of oil pollution have already been considered (see Location under the analysis of Water Pollution). It has been estimated that 23% of the oil introduced into the world's waters by other then natural seeps and pleasure craft comes from ships (48). Most of this, 21%, comes from normal operations such as bilge cleanout of tankers and other ships; however, most of the research and public attention has focused on the 2% caused by accidents probably because of their spectacular concentration in relatively small areas close to shore. Of the total number of oil spills over 100 barrels reported in U.S. waters in 1968 and 1969, about half were from vessels, a third were from shore facilities and the remainder were unidentified (43). During the decade of the 60's, over 550 tanker collisions occurred. Four-fifths of them involved ships entering or leaving ports (128). Approaches for controlling oil pollution include determining the ecological effects, minimizing the chance of accidents and improving the cleanup efficiency for those accidents which do occur.

Currently, the actual long-term effects on marine biota are not clearly known. The Plymouth Laboratory's study of the TORREY CANYON case concluded that "except for serious effects on some species of sea birds, the oil was not lethal to flora and fauna." (31) Most damage was caused by detergents. A subsequent report concluded that "it is unlikely that any serious permanent damage will have occurred even after the colossel spillage experienced when the TORREY CANYON went aground...however, ...large amounts of oil could have been far more damaging in other areas...[especially]...in areas liable to repeated spills...[causing] chronic pollution of marshes." (104) During World War II, mass spillage of oil off the east coast of the United States was almost a daily event, yet wide-spread ecological disruptions apparently did not occur. Followup ecological studies in the Santa Barbara area have apparently revealed little significant persisting imprint on the region's ecology, although definitive reports have not yet been completed. The Smithsonian Institution is currently analyzing the ecological effects of an oil spill which occurred adjacent to their facility on the Pacific side of the Panama Canal.

In contrast to the above cautiously reassuring research conclusions, Woods Hole Oceanographic Institute reportedly considers oil pollution to be a major current threat to marine biology on a global basis. The polar extremes of these conclusions from widely respected sources on such an important subject indicates that here is an area of badly needed, intraprofessional communication.

While research on the effects is underway, alternative ways are being considered to minimize the accident potential. These include: international conventions, international standards for ship construction and operation, safety regulation by the Coast Guard, increased surveillance, harbor advisory radar systems, emergency oil transfer and storage systems, cooperation of private industry and port authorities, radio telephones, licensing of towboat operators and financing cleanup operations (128).

A third set of alternatives involves cleanup efficiency for those oil spills which do occur. Measures include containment, removal and restoration. Each has many alternatives of its own. Major research is underway on these methods, but the most successful solutions to date still seem to be straw and nature.

Many believe that the most serious conflict between fishing and marine transportation can occur through the dredging process necessary to provide and maintain shipping channels. Deleterious side effects can occur in the removal operation, in the deposition of spoil and in changes in hydrodynamic conditions induced by dredging which changes bottom configuration in key locations.

Benthic life in the actual removal area is for the most part destroyed. Adjacent benthic organisms can be smothered by the local sedimentation temporarily induced, but eventual restoration to the pre-dredging population appears to be largely a matter of time, say a year or two (33), (111). Where the bottom is covered with oxygen-demanding sediments generated largely by the upstream activities of man (a common case), the dredging process can cause a temporarily increased dispersion of this BOD and cause localized reductions or even depletion of dissolved oxygen. The significance of all of these effects on fishing is measured in their time-space distribution, the ability of some fish to move away from the disturbance and the degree to which the area would be otherwise fishable.

Marine life in the disposal areas can be affected to a much greater degree than it can in the removal areas. If, for example, the spoil is deposited in wetland areas, the significance of the damage will vary with the extent of coverage and the biological productivity of the particular wetland. That wetlands play a vital role in the production of marine life is widely recognized. However, essential information for the decision maker is still basically lacking. According to the Bureau of Commercial Fisheries, about

65 percent of our Nations commercial fish catch is "estuarine dependent," i.e., spends any significant part of its life cycle living in or passing through estuaries (170). The percentage varies widely by region. For example, within the NAR "estuarine dependency," the average is about 27% in New England and 93% in the Chesapeake Bay States (Table U-3). Even within these areas some wetlands must be more essential than others. The disposal of spoil, whether it be in wetlands, out to sea or elsewhere, should be based upon more usable knowledge. Instead of a curse, with improved knowledge the disposal of dredging spoil can be turned into an advantage by (1) creating more wetlands, (2) improving less productive wetlands or turning them into more desired land uses, or (3) avoiding wetlands completely. The following are some examples of imaginative efforts of this type in which ecological and social improvements are being attempted. Dredge spoil from pending Mobile and Tampa harbor projects will be used to create spoil islands which will be converted into wildlife refuges. At Tampa they will be sloped to create ideal conditions for additional fish nurseries. Some at Mobile will be doughnut-shaped to enhance growth of wildlife. In San Diego and in Hampton Roads spoil was used to build up the shoreline and provide additional space for ports. In St. Joseph's harbor spoil is to be used to reduce further beach erosion. Near Detroit existing spoil islands will become wildlife and parks areas.

Disposal at sea can also present problems and uncertainties. Benthic life in and adjacent to the immediate disposal area can be smothered. Dependent upon the pullutant loads in the dredged material and dispursing currents in the disposal area, other effects can be induced such as localized oxygen depletion and chemical poisoning on the one hand and nutrient enrichment on the other.

The removal and deposition operations can change the bottom and shoreline configuration sufficiently to alter the current with consequent changes in chemical and biological concentrations in the water column. Thus dredging techniques might help flush out Great South Bay on Long Island and thereby provide increased recreational advantages and major savings in waste treatment costs. But the resultant increase in salinity might affect those sectors of the shellfish industry whose preservation depends upon maintaining the current fresh water-saline gradient.

Whatever mix of values is most desired by an informed society, dredging can often be used to reinforce them. Unfortunately, current knowledge of key biological factors and society's preferences is too obscure to permit the decisions that must be made, whether by action or inaction, to be made in full confidence.

Another significant dredging-type concern hinges around the desirability or undesirability of leaving deep holes for fish.

Young fish of several important species such as striped bass and croker occupy deep holes in winter (33). On the other hand, some conclude that such holes tend to concentrate organic sediment whose decomposition could produce localized areas of oxygen deficiency. Even in the latter case, it is not known whether it is of net overall benefit to concentrate BOD in a few places like this or to distribute it more widely to many places.

The extraction of non-living resources can be affected where sea lanes pass through or near the extraction area. At present, this conflict is more hypothetical than real in the NAR region. But off the Louisiana coast where oil wells are common this is a significant problem. It is being minimized by defining shipping lanes and providing more sophisticated navigational and warning devices aboard ships, in the channels and on the well platforms. These actions are costly and are not a complete safeguard against unfortunate collisions particularly during weather disturbances and periods of low visibility. Should some forecasts for petroleum extraction on the NAR's continental shelf be borne out, this type of problem would become real in this area.

Waste disposal can be affected by marine transportation in the vicinity of the ship's berth. It should be relatively easy to minimize this problem through the installation of pump-out facilities or other alternatives at the ports. Deballasting at sea is a significant problem especially if it occurs close to the coast. This, too, is a problem which can be overcome, with some design changes, in ships. A harder job is policing to fix blame on the violator. Various systems of "fingerprinting" the oil through identifiable but harmless concentrations of radioactive isotopes are currently being considered.

Recreation can be affected in several ways. Marine transportation can deny or limit swimming, boating and other recreational use of the port area itself and its associated shipping lanes. Oil spills which result from tanker accidents can deny large stretches of the beach to recreational use for varying periods depending upon the intensity of the cleanup action and weather conditions. This conflict occurs during the summer. In the winter recreational beach demand is relatively small and the frequency and intensity of storms which provide natural cleansing action is at its highest. In winter nature may be the most effective remedy.

Aesthetic satisfaction can also be influenced by marine transportation. Ports used to be among the sights of the city much more than they are today. The arrival of the Queen Mary or "The Fleet" in New York was a source of local pride and an attraction for sightseers. Restaurants featuring a nautical theme were important occupants of the waterfront. Over the past three decades ports have become considerably more remote to the inhabitants and visitors in port cities. In the public eye they seem to have developed an image of deterioration, squalor, noise, dirt, garbage and congestion. Few schools ever select a port for a field trip. Even if they tried, they might not succeed. A visit to the Port of Elizabeth today, for example, would be met with a large fence, public-keep-out signs, and a hostile rejection even to those who are the most motivated and persistent in seeking out someone with sufficient authority to grant them permission to enter.

It would seem that problems of security, safety and access could be solved and at least the more modern containership and tanker facilities could be presented to the public for what they really are, rather spectacular objects for public observation. Public observation platforms with attractive facilities and informed attendants might even pay for themselves especially if the badly-needed effort to improve the public image is given any weight whatsoever. Until and unless things like this are done, ports will continue to be considered an aesthetic blight to most.

No conflicts between marine transportation and national defense are identified; they tend to compliment each other.

Land use interrelationships are significant. Although ports use only a tiny fraction of the shoreline, this fraction has a weighted value for many uses probably higher than that of any other part of the coast. An extreme example is Downtown Manhattan. Several hundred acres of new land there are planned to be created by filling out to the bulkhead line an area formerly used for finger piers. With average assessed valuations in the vicinity running over $3 million an acre, the total assessed value of this surrendered port property is in the billion dollar range. So it is clear that although ports occupy very little of our coast, there is great real competition for alternative uses of this property. Here again, it is possible that this apparent problem in combination with another problem -- what to do with dredging fill -- could be turned to an advantage. The demand for increasingly large tracts of land for storage adjacent to the waterfront combined with the high cost of expanding inland is producing a strong trend to expand some ports seaward by landfill even up to depths of 30 to 40 feet. It might be possible that a far-sighted port could meet this future need by providing a close-in disposal area with minimal environmental side effects. Of course, the adequacy of the rather low quality fill would complicate the solution, but the elements of a possible solution are visible considering that the big space consumer is container or bulk storage. Both are characterized by uniformly distributed unit loads. It might be economically feasible to reinforce the carrying capacity of the remaining, rather limited, high unit load areas by a combination of piling, heavier slabs, and redesigned wheel systems.

Solutions. Since containerships, break-bulk cargo carriers and passenger vessels can generally be accommodated in existing ports, the analysis of solutions will be primarily directed at the two vessel types which do present major problems -- the deep-draft tankers and dry-bulk carriers. Solutions will be considered as non-structural and structural in that order.

A non-structural alternative solution is to minimize trans-oceanic transportation needs by a major shift in National policy towards internal self-sufficiency. Under this concept, the Nation would satisfy most of its needs by consuming its own raw materials such as petroleum and ore. All our oil, for example, might be produced at home to include the possibility of oil extraction off the coast. All movements would thus be by internal transportation. This possibility is deemed completely unrealistic in the face of governing non-isolationist considerations such as national defense, national insufficiency in raw materials, and the politics of international intercourse including the economies of the source areas. It is cheaper to ship a barrel of crude oil from as far away as the Persian Gulf than it is to move it overland from Texas. If the NAR is to receive a major part of its oil from Alaska in the future, marine transportation and overland pipelines will have to compete on both economic and environmental terms.

Transoceanic pipelines were dismissed earlier as impracticable. Air transportation is a competitor. On a value basis, it has already made much more significant inroads than is often realized. Except for the cruise trade, it has taken away virtually <u>all</u> of the trans-oceanic movement of people. The increasing inroads of air on cargo transport are illustrated by U-14.

TABLE U-14

IMPORTS AND EXPORTS -- VESSELS AND AIR

	(Billion Pounds)			(Billion Dollars)		
	1955	1965	1968	1955	1965	1968
Vessel	508	854	955	17.3	31.9	40.7
Air	NA	.65	1.09	NA	3.6	6.3

SOURCE: (140)

In terms of value, note that vessel shipments were up 135% in the period 1955-1968 (up 27% since 1965) whereas air shipments were up 75% just since 1965. Vessels carry about 1,000 times the tonnage but only 6-1/2 times the value of air. As planes become larger the proportionate bite of the airborne competition will increase. Notwithstanding this perspective, it is very clear that for even the most distantly perceivable future, the heavier commodities will be carried by ocean shipping.

Before considering structural alternatives for deep-draft vessels, it will be recalled for from earlier comments that:

- No existing major regional port has the depth necessary even to come close to accommodating any of the range of larger tankers forecast without going through at least 17 feet of conventional dredging, rock, continental shelf and probably prohibitive other obstacles; assuming the optimum economic vessel design is used.

- No existing major regional port has the depth necessary to accommodate the full range of the larger dry-bulk carriers forecast, although Portland, New York and the Virginia ports can accommodate a few at the lower end of the spectrum. Providence and Baltimore could also get into the bottom of this spectrum by deepening of 5 feet or less without encountering major obstacles. The inner harbor of Portland can not be deepened further without encountering major obstacles. Presumably some of the other ports mentioned earlier could be deepened, but the cost of going down another 12 to 17 feet, even with conventional dredging to accommodate the full range of vessels forecast, and maintaining that depth, could be astronomical.

Techniques which might minimize or overcome the depth limitations include using the LASH and SEEBEE concepts, developing offshore unloading facilities, and redesign of vessels.

Much more operational experience is needed to evaluate the LASH and SEEBEE concepts in which self-propelled, shallow draft barges are carried aboard very large deep draft ocean vessels and offloaded to serve shallow harbors and river systems. It could be, for example, that it would be no more costly to forget the potential economies of scale and continue using the current "small" dry bulk carriers. The performance of these ships in the Gulf needs to be followed very closely.

Offshore tanker unloading facilities are already used in other parts of the world. For dry bulk carriers, the problem is much more formidable, but potentially solvable. A major problem would be bulk storage. Storage of significant quantities of heavy bulk materials on an offshore platform would present mammouth problems because of the weight and the large storage space required. Slurry pipelines have been reported feasible for coal and their use is being planned for iron ore in Australia, India, Alaska, Peru and Japan (55). At some stage the water or other liquid vehicle would have to be removed. This process might require major environmental controls to avoid local pollution. Alternatively, the bulk material could be moved directly to shallower draft vessels for coastwise distribution to existing ports. However, this solution would require a very sophisticated, problem-prone scheduling system if the number of feeder barges were to be kept to a level which would not negate many of the economies of scale which are being sought. Another possible solution is to move the material to the adjacent shoreline for surge storage by barge, conveyor or screw. This approach means double handling.

Vessels can be redesigned to take advantage of some of the economies of scale despite depth limitations. For example, although the most economical 175,000 d.w.t. bulk carrier would draw about 58' of water, a vessel of this capacity drawing less than 50' has been designed by lengthening and widening the optimum design.

The problem of adequate depths, however, is not the only one. Environmental and safety problems could be even more significant. To illustrate, strong public opposition has already been voiced towards proposals to locate tanker unloading facilities in deep water off such places as Machiasport, Maine; eastern Long Island (with considerable opposition coming from neighboring Connecticut); northern New Jersey, and lower Delaware Bay.

A number of Federal agencies listed later in this analysis, the American Association of Port Authorities and others have each been studying the deep-draft problem intensively. A major need is a cooperative port study concentrating on supercarrier accommodations in this region. One possible outcome of such a regional study, an outcome which might also be acceptable to the affected states, is suggested below to provide a basis for further analysis. It is emphasized, however, that much further study will be required to reach the most acceptable solution. Whatever that solution may be, it may be anticipated that it will reflect many of the points brought out below.

For a deep-draft tanker facility, a solution might include the following:

- A major unloading facility will be located in protected deep water offshore so as to require little dredging. It will have a possibility of later improvement to accommodate tankers even larger than the 55-65 foot draft vessels currently projected for the year 2000.

- The facility will be located in reasonable proximity to existing refineries to facilitate possible pipeline movements.

- The facility will be located some distance from major cities to limit possible environmental problems.

- The facility will incorporate the most elaborate safety provisions known and will undergo constant scrutiny.

- Environmental considerations, to include ecological, recreational and aesthetic aspects, will receive extensive recognition.

- Major public hearings will preface any final decision.

- The public will benefit significantly in the form of reduced cost of petroleum products and the secondary effects induced thereby.

- Some tradeoffs will be necessary, because no project such as this can be completely free of disadvantages.

One area that could come close to meeting all these requirements is lower Delaware Bay. Another possibility is a naturally deep facility such as that proposed for Machiasport, Maine. The 90-foot depths there, a mile wide entrance channel and a four-mile turn around area for the tankers are compelling assets. A disadvantage is the $150 million or more required to construct a refinery from scratch and the distance from major domestic markets. The latter problem would be less significant if a foreign trade zone were established.

In addition to one or more major facilities, there will be some secondary facilities serving smaller transoceanic tankers for special purposes. One such possibility is Casco Bay near Portland, Maine to serve the Montreal trade.

In addition to the primary and secondary facilities, there will be a continuing need for the coastwise distribution of petroleum projects from the major unloading facilities in crude form. This traffic will continue to be highly competitive not only within the coastwise shipping industry but also against the possible competition of pipeline distribution. Currently, coastwise shipping enjoys a natural advantage because most of the larger consumption centers are on the coast and the basic facilities, harbors and distribution systems already exist. However, the pipeline alternative is a viable one, economically and environmentally. In recent years a pipeline has largely surplanted the once heavily used barge distribution system on the New York State Barge Canal.

For a deep draft dry-bulk cargo facility, the situation is cloudier. A solution might include the following:

- Probably there will be several facilities preferably adjacent to shore to facilitate the shoreward movement and stockpiling of the bulk cargo; however, shoreward movement by a slurry pipeline may be an acceptable alternative.

- Ideally, the facilities would be adjacent to the major points of consumption to reduce rehandling costs. A case in point would be

Sparrows Point near Baltimore.

- Ideally, the facilities would have a sophisticated capability of transferring <u>all</u> of that portion of their cargo which is intended for coastwise and inland barge distribution directly to the barges. However, because of scheduling problems introduced by weather, strikes and other uncertainties, significant onshore storage areas would be required.

- Since much of the bulk cargo would undoubtedly move to and from inland points by means other than barge, the facility should be adjacent to existing high capacity rail nets.

- A combination of some of the alternatives mentioned earlier might be employed. Thus, a large dry-bulk carrier might berth in deep water adjacent to a platform large enough to accommodate necessary transfer and servicing facilities. Cargo would be transferred preferentially to whatever coastwise barges could be economically accumulated. Discontinuities in this preferred unloading would be filled with locally based barges to transfer the cargo to the adjacent shoreline where there would be surge storage and inland distribution facilities. When the carrier becomes light enough through these processes, it would move to the adjacent shallower shorelines to complete its unloading again giving preference to coastwise distribution barges to cut down double handling.

- Most of the other points made above for the supertanker facility apply as well to superbulk carrier facilities.

There are several candidate ports.

The Virginia ports around Norfolk are currently geared to handling essentially all of the region's extensive coal export trade. Among other things, Norfolk has good depth, storage facilities and a connecting rail system. The 57-foot depth of the Chesapeake Bay Tunnel would be a consideration, but as earlier comments showed, especially Figure U-11, it would still allow passage of the full range of large dry-bulk carriers projected for the U.S. trade up until the year 2000.

Sparrows Point, near Baltimore, is a heavy bulk consumer of iron ore. The existing channel would have to be deepened. Possibly, incoming iron ore carriers could move when empty to Norfolk to take the coal exports there, if suitable trade routes could be arranged.

The Delaware Bay tanker unloading area, if is comes to fruition, is also somewhat near the heavy iron ore consumption in the Philadelphia area.

Portland and Providence have some depth advantages, but they are far from bulk consumption points.

Costs. The cost of providing a "conventional" solution -- deepening existing channels -- is not worth much detailed consideration. To illustrate, taking an admittedly severe case, it has been estimated that deepening the existing Delaware channel to Philadelphia to only 50 feet would cost on the order of $200 million. What it would cost to deepen it to the range necessary to accommodate the drafts envisioned for the supertankers has not even been estimated.

Alternatively, the cost of providing a 72-foot channel to an offshore tanker offloading facility in lower Delaware Bay, the only protected naturally deep water on the East Coast between Maine and Mexico, has been estimated in a preliminary way by the Army Corps of Engineers at about $15 million (25). Such a depth, after allowing for squat, freshwater buoyancy loss, motion in the sea and a safety factor, would accommodate drafts of 65 feet. Drafts of 70 feet might be accommodated there for about $40 million. These channel improvement costs would probably be borne by the Federal government. The cost of the facility itself is unknown, but it would probably be borne by the non-federal sector. An offshore oil loading facility at Bantry Bay, Ireland, resportedly cost about $25 million. Such an order-of-magnitude cost would be relatively small compared to annual benefits, the recent $175 million investment in Port Elizabeth and the estimated all-time $5 billion of non-Federal expenditures. 1/

As might be expected the cost of providing a channel to accommodate 50-foot draft dry-bulk carriers at dockside will vary greatly with location. According to Appendix K (Navigation), a 57-foot channel would cost about $30 million at Newport News and about 10 times this cost at Baltimore. It is noted that Congress has authorized deepening the channel to Baltimore to 50 feet at an estimated cost of $100 million.

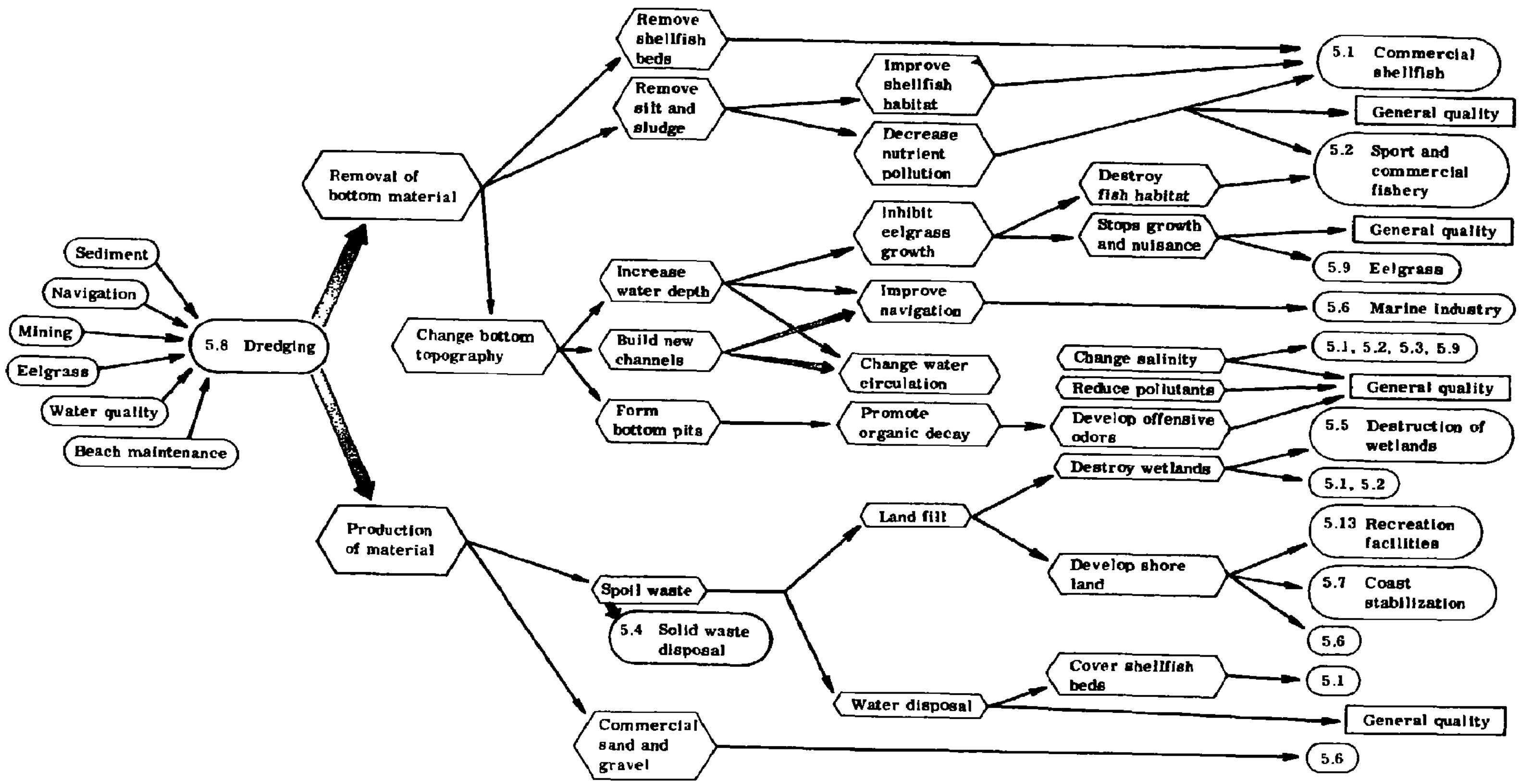
Indirect costs, by definition, are much harder to estimate. It should be one of the major purposes of the proposed cooperative study and the public hearings to pinpoint these costs, and insofar as feasible, make the solution bear them.

A number of possible indirect costs were identified earlier

1/ Some related national figures are: All-time Federal expenditure including maintenance is about $1.5 billion. The value of U.S. oceanborne commerce, imports plus exports, was about $41 billion in 1968. Customs collections at marine terminals for fiscal year 1969 totalled about $3 billion (5).

under Parties Affected and general approaches were suggested. Because of site-specific considerations, it is not feasible in this study to go much beyond the level already covered. To illustrate some of the interrelationships that an analysis of one phase of indirect costs might take, see Figure U-12. This network, although incomplete, is a form of schematic checklist. It can be used by competent people in several ways. For example, where there exists a general background knowledge of the importance of various uses in the vicinity of a proposed dredging operation, a planner could see how the dredging could potentially affect these uses. The network could steer him in a logical priority-oriented path. Similarily a review of the network could pinpoint gaps in current data and knowledge and so illuminate the relative safety or risk of the undertaking. Especially where undertainty peaks at nodes of high value, caution is indicated in the form of priority research, data collection, monitoring, redesign, or delay.

A possible additional indirect cost of a single regional superfacility is the potential weakening of the strong existing competition which tends to hold prices down to the level of the more efficient producers.



A NETWORK ANALYSIS OF DREDGING

SOURCE: (21)

FIGURE U-12

Benefits. The principal direct benefits are economic. The potential for major savings is illustrated by the new 326,000-DWT tankers currently transporting bulk petroleum on the 22,000 mile-round trip from Kuwait to Bantry Bay, Ireland via the Cape of Good Hope. These tankers can deliver a barrel of oil at one half the operating cost incurred in shipping through Suez with 50,000 DWT ships even though the distance is some 13,000 miles longer (135). Some further economies are gained in shipbuilding. For example, it costs only about two-thirds as much per DWT to construct a 326,000-DWT tanker than it does to construct a 50,000-DWT tanker (2). Within the NAR the economic gains might be somewhat less attractive but still be large. The significant factors are efficiency gains and the volume of traffic to which these efficiencies would apply.

Deep draft facilities adequate to accommodate the tankers and drybulk carriers projected earlier for this region could cut the cost of supplying the region's petroleum needs by an estimated $100 million or more annually. (Appendix K - Navigation). The estimate is based upon the present bulk tonnage which could be carried by these supervessels and is, therefore, very responsive to bulk demand growth, import quotas and the possibility of free ports.

Indirect benefits would fall largely in the areas of (1) national defense, (2) improved economic well-being, (3) reduction in the probability per gallon of oil spills by concentrating volume movements in relatively fewer, more readily monitored vessels whose value could easily justify the very best in navigational, shipbuilding, and other safety precautions and (4) international balance of payments. Three examples of the latter would stem from improved competition with Canadian ports, a foreign trade zone which imports inexpensive crude and exports more valuable refined petroleum products, and an improved ability to compete with foreign markets in the sale of U.S. coal.

Organizational Considerations. Three Federal agencies are principally involved.

The U.S. Army, through its Corps of Engineers, is responsible for providing and maintaining channels, harbors and protective structures; for granting coastal construction permits; for prescribing some navigational regulations; for removing wrecks when they interfere with navigation; for collecting, compiling and publishing information on the volume and nature of waterborne commerce and the physical characteristics of U.S. ports; for establishing harbor lines beyond which no structures may be erected without permit; for supervising the harbors of New York, Baltimore and Hampton Roads; and for controlling the placing of refuse and dredging in all harbors.

The U.S. Department of Commerce, expresses its principal marine transportation interests through its Maritime Administration (MARAD) and its Environmental Science Services Administration (ESSA). Under Section 8 of the Merchant Marine Act of 1920, MARAD has broad authorization "in cooperation with the Secretary of War" to investigate and advise with respect to port development with emphasis on reduction of port congestion, efficient exchange from ship to land transportation, terminal facilities and port throughput. ESSA provides coastal charts and weather warning services. The National Oceanic and Atmospheric Agency (NOAA), recently established under Commerce, absorbed ESSA - along with a number of other non-transportation-oriented agencies. NOAA's responsibilities and its impact on the problem discussed herein are not yet fully known.

The U.S. Department of Transportation is charged with the development of national transporation policies and programs, with some specific exceptions in the area of water resource projects under Section 7 of PL 89-670. The Department's main impacts are on port throughput operations especially in the landward, non-waterborne distribution system and on the seaward side through its administration of the Coast Guard.

Bi-state port agencies exist in New York-New Jersey and in Philadelphia-Camden. State port agencies exist in Maine, Massachusetts, Maryland, and Virginia. New York, Philadelphia, Wilmington and Norfolk also have city agencies.

The principal non-governmental institutions are the American Association of Port Authorities and the American Petroleum Institute.

Two possible organizational problems are:

° The coming together of the major governmental and non-governmental interests in the proposed cooperative study. This might be accomplished in a regional port study when the participants have each made their necessary prior preparation. The study should recognize and foster the competitive aspects which have kept the U.S. transportation industry viable. Yet it should also identify and resolve those aspects which suggest a cooperative regional approach -- such as the provision of deep-draft facilities.

° The relationship between the various port authorities and the various coastal zone institutions which are coming into being in many states.

The effectiveness of the general solutions considered herein can be summarized in terms of the three objectives of the NAR study.

From a national efficiency viewpoint, it has been seen that the cost of satisfying current requirements for bulk products can be reduced about $100 million or more annually. Federal costs to provide an adequate channel to an offshore tanker unloading facility might be in the vicinity of $15-45 million first cost. Estimated costs of providing a channel to dockside for the major deep-draft dry-bulk vessels vary greatly with location, say $30 million at Newport News and ten times that much at Baltimore.

From a regional development viewpoint, major savings in the cost or the region's fuel for its heating, transportation, power and industrial needs should favorably influence the region's cost of living and competitive position. Similarly, major savings in the cost of iron ore imports and coal exports should also improve the region's competitive position.

Environmental quality effects vary with the viewpoint. Viewed narrowly in terms of the sites themselves, the deep-draft facilities would probably produce some degradation of environmental quality. No matter how stringent the environmental measures, it is unlikely that the completed operating facilities could represent a net improvement to the current, relatively unused waters the sites now occupy. However, in comparison with the present small-scale scattered operations, the proposed large scale operation in a few controlled locations ought to produce a much safer and more environmentally acceptable solution.

COASTAL EROSION AND TIDAL FLOODING

Nature of the Problem. Storms and erosion are geophysical phenomena resulting from energy dissipation. Without technological breakthroughs in weather modification, they are uncontrollable by man. The problem considered here is how to minimize coastal erosion and tidal flooding damages in an economically and environmentally acceptable way.

Recurrence of storms of record in this region can cause about $1 billion in property damages plus significant loss of life and major alteration of ecosystems. A single rare but meteorologically predictable storm in New York Harbor could cause about $5 billion in direct and indirect damages. Coastal erosion can limit beach recreation, waterfront development and wetlands protection.

This analysis focuses on those erosion and flooding problems which are directly influenced by the sea. Often these seaborne influences combine with other influences from inland and from the atmosphere to magnify erosion and flooding problem and these instances are considered. Not considered, however, are erosion and flooding problems which occur primarily inland--even though these inland disturbances and the means taken to control them can ultimately affect the quantity and quality of riverine inputs to the coastal zone. (See Appendix E on flood control.) Reflecting the scope of the overall NAR study, this appendix remains general and does not recommend individual projects or inventory past or recent project proposals, except for illustration.

Causes of the Problem. The principal causes of the problem are the forces of nature, the characteristics of the coastal area subjected to these forces and some special major limitations on solutions. Since the later analysis of possible solutions is keyed to these causes, an initial understanding of them is necessary.

The first major cause of the problem, the forces of nature, involves storms, littoral drift, and tides. A more complete discussion of these and other forces of nature may be found in (8) and (134).

Almost all significant coastal flooding and most coastal erosion occurs during storms, the most intense of which are the tropically-spawned hurricanes. Hurricanes affecting this region travel generally from south to north. (Figure U-13) Important properties of storms are their intensity, duration and frequency, and the high waves, runoff and winds associated with them.

A hurricane, by definition, has winds exceeding 75 miles per hour. Storms of less intensity can sometimes produce equal or more severe effects when combined with other forces to be discussed more fully below. An example is the "northeaster" of December 29, 1959. The

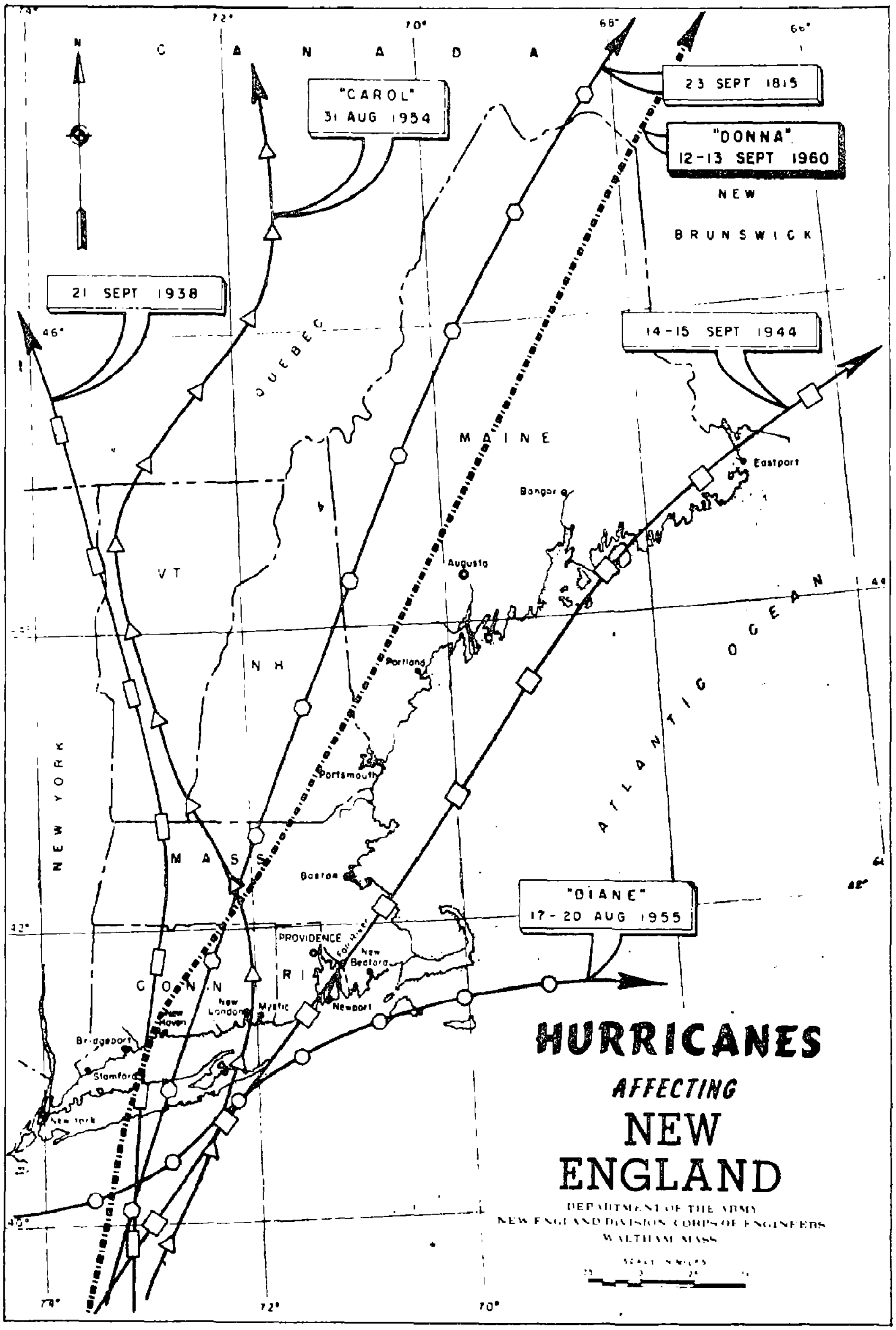

CANADA
"CAROL"
31 AUG 1954
23 SEPT 1815
"DONNA"
12-13 SEPT 1960
NEW
BRUNSWICK
21 SEPT 1938
14-15 SEPT 1944
QUEBEC
MAINE
Eastport
Bangor
Augusta
VT
NH
Portland
Portsmouth
NEW YORK
MASS
Boston
ATLANTIC OCEAN
"DIANE"
17-20 AUG 1955
PROVIDENCE
Fall River
New Bedford
RI
CONN
New Haven
New London
Mystic
Newport
Bridgeport
Stamford
New York
HURRICANES
AFFECTING
NEW
ENGLAND

FIGURE U-13

winds were only 25 to 30 miles per hour, but they were steady and blew directly onshore over a long fetch of ocean. This wind occurred at a time of very high spring tide and produced record or near record water levels along the Maine, New Hampshire and northern Massachussets coastline.

The duration of a storm is an important consideration. If a storm persists, waves can build up to great heights and be superimposed upon one or more high tides.

The severe low-frequency storms produce the highest average annual damage. The less severe low-frequency storms tend to have permanent influences on the strength and direction of the longshore transport of sand which affects erosion. The frequency of storms of a given intensity varies with location. Thus the coast north of Cape Cod is historically not subject to hurricanes, but south of this cape, hurricane frequency increases greatly. The apparently most susceptible area stretches roughly from New York City to Buzzards Bay. Not coincidently, this is the part of the region's Atlantic Coast which has a predominately east-west orientation, perpendicular to the usual hurricane track.

The friction between water and a fast moving mass of air, working for days over a fetch of 10 miles or more can produce tremendous waves. Thus waves are higher in the ocean, not only because of the insignificant bottom drag there but also because of fetch. Of the forces which create large waves, fetch when combined with a wind of long duration, is probably the most important. Fetch can account for some major broad or local variations in wave intensity. Thus the south shore of Long Island is more vulnerable to most Atlantic storms than the Connecticut coastline because of marked differences in fetch. On a more local level, the "northeaster" generally has little effect on the Rhode Island coastline with the exception of the town of Narragansett against which these winds blow over a fetch of some 25 miles or more. The energy of waves coming from this direction is about 50 to 75% greater on this shoreline than the energy of waves from the south. (136)

Hurricanes and other storms which come in from the ocean usually produce intense rainfall, often of record proportions. This precipitation usually falls on already well saturated ground and produces extreme runoffs. As will be seen, these often find difficulty venting to the sea because of other storm related phenomena.

High winds associated with storms not only influence surface water dynamics, but also impact upon natural and man-made vertical faces, just at a time when water saturation has weakened their foundations. Wind velocities are generally higher for storms coming in from the ocean than for land based storms, probably because of decreased friction at the ocean's surface.

It is rather common on sandy coastlines for the larger winter storms to move sand from the beach into offshore waters. The normally gentler summer waves then return substantial amounts of it. This natural annual cycle is fortuitous, because it results in a slower loss of the beach area and a deeper beach, just when it is most needed--during the summer outdoor recreation season.

However another factor, littoral drift, is not so fortuitous. Because of the Coriolis force produced by the earth's rotation, and because of the orientation of the coastline to prevailing wind-induced wave fronts, there is usually a longshore current which moves sand along the coast. Generally along the ocean shore front in this region this littoral drift is southward. Its intensity varies greatly from place to place and from season to season and usually results in the net erosion or accretion of sand. There are many local exceptions to this generally southward drift. At places such as Cape Cod, Sandy Hook and Bethany Beach, Delaware a node exists. The local littoral drift moves both northward and southward from these nodes. The shorefront opposite them is subject to erosion with little opportunity for a compensating accretion. In some places erosion can be dramatic. Hog Island on the Virginia Peninsula, for example, is losing about 50 feet annually (136).

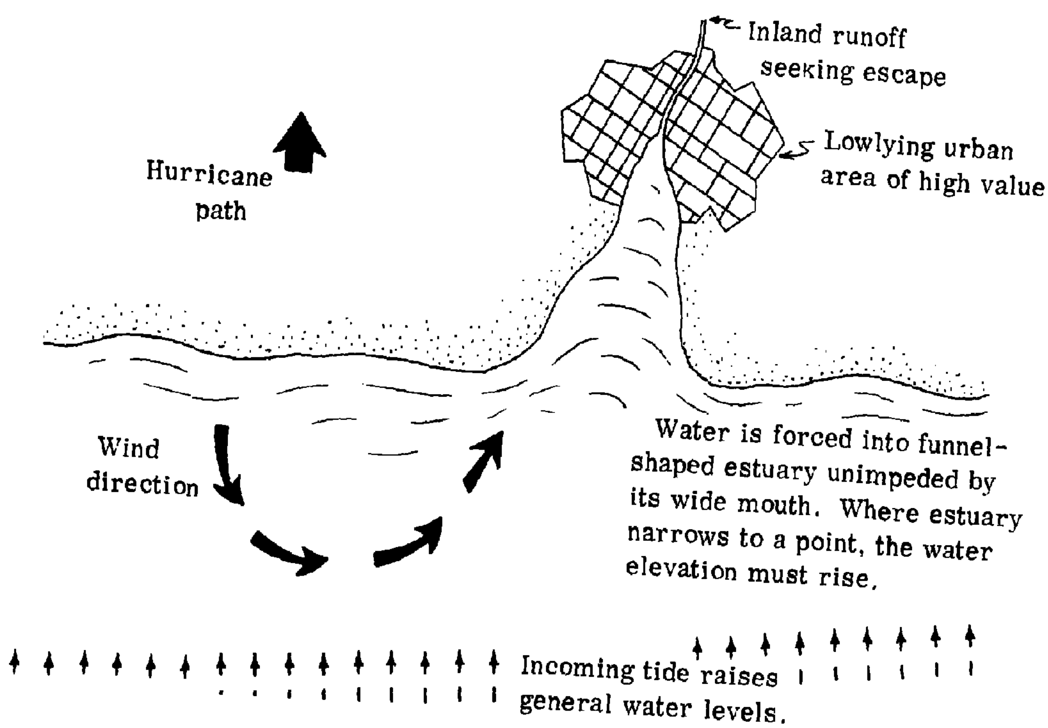
When high tides are coincident with the other forces of nature cited here, they can greatly magnify total effects.

A second major factor influencing erosion lies in the characteristics of the coastline upon which the forces of nature impact. The principal characteristics here include the orientation, configuration, resiliency and human value of the coastline.

As has been seen, an unfavorable orientation can magnify littoral drift and increase fetch. An even more important consequence of orientation is a quadrant effect caused by the circular motion of storm winds. This effect is exemplified by the hurricane. In the northern hemisphere because of the rotation of the earth, winds blow counterclockwise, as seen from above, about a low pressure center. Thus, in this region, the winds in one quadrant of a hurricane crossing the coast will be away from the coast producing relatively little damage and those in the opposite quadrant will pile up water against the shore. Thus it will tend to cause extraordinary littoral movement.

Funnel shaped estuaries with wide openings and narrow necks are at a particular disadvantage. A large mass of water can easily enter the estuary with great momentum. As the estuary narrows the only direction this water can move is upward.

When the funnel effect is combined with the quadrant wind effect, with high tide and with inland runoff in urban areas, conditions become especially severe as depicted in Figure U-14.



SOME COMBINED CLIMATOLOGICAL EFFECTS

FIGURE U-14

Beaches are energy dissipaters. Their efficiency in this role is greatly influenced by their profile. The nearer deep water is to the shore, the closer large waves can approach before their energy begins to dissipate because of bottom drag. The flatter the gradient both offshore and on the beach "run up" area, the longer and more gradual is this dissipation. A narrow, steep beach will be subject to much greater wave forces than a flatter beach. An offshore bar, breakwater or island will dissipate waves affording protection within the areas they shelter. However, offshore shoals and islands also tend to focus energy, resulting in sporadic concentrated damage areas along the shorefront.

Moving inland, during periods of high water well-established dunes provide a similar beneficial effect. Dunes also act as dikes against inundation. Thus a flat beach is an excellent energy dissipater, but unless it is back up by higher ground inland, large areas can be inundated. A narrow, low barrier beach without dunes is particularly vulnerable to storm breaching with potentially important resulting effects on the ecosystems of these large back bays which had adjusted to a significantly different salinity regime. For example, it is possible that the change in salinity created by this potentially colossal change in bay hydraulics could greatly effect an oyster industry located there.

The resiliency of the coastline to water dynamics depends upon the material of which the shorefront is composed. Of progressively diminishing resiliency in their ability to withstand wave forces are the rocky coasts of Maine, the sandy beaches of Long Island, the wetlands throughout the region and the silty-clay bluffs of Chesapeake Bay.

Human values along the coastline are more concentrated in some reaches than in others. Thus a great storm in the New York City area would have a much greater human consequence than one striking northern Maine. The hurricane of 1938 killed about 250 people in Providence and caused damages there of about $125 million (31).

Table U-15 summarizes significant shorefront information. For the purposes of this appendix, these data were based on the National Shoreline Study (136). This study mainly considers the enter rea-coast and includes shores of bays and estuaries such as Chesapeake Bay, Delaware Bay, Delaware River entrance and the large inner bay landmark of the barrier beaches where erosion is likely to be a problem. It should be noted that estimates of shoreline length vary depending upon measurement criteria; detail shore length in some states may be considerally greater than that given in the table.

By distinguishing between ocean and estuarine shorelines, several major perspectives emerge. There is almost no beach front in Maine and in the estuaries, but along the ocean, except for Maine,

TABLE U-15

SHORELINE CLASSIFICATION SUMMARY

(Miles of shore, including ocean, estuary and bay frontages)

	Va.	Md.	Del.	N. J.	N. Y.	Conn.	R. I.	Mass.	N. H.	Me.	Totals
Physical Characteristics											
Beach	294	46	76	215	331	145	185	940	25	60	2,317
No beach	699	1,893	150	254	307	125	155	260	15	2,440	6,298
Historical Shore Changes											
Critical Erosion	258	180	31	122	299	25	25	135	2	20	1,097
Non-Critical Erosion	300	1,500	28	110	339	240	310	1,030	36	2,475	6,368
Non-Eroding	435	259	167	237	0	5	5	35	2	5	1,150
Shore Ownership											
Federal	109	225	12	67	34	5	10	90	2	20	574
Public	115	35	46	130	202	50	50	175	10	60	873
Private	769	1,679	168	272	402	215	280	935	28	2,420	7,168
Uncertain	0	0	0	0	0	0	0	0	0	0	0
Shore Use											
Public rec.	50	105	33	290	210	30	50	235	8	13	1,024
Private rec.	56	111	34	35	70	225	270	800	30	967	2,598
Non rec.	155	1,623	3	12	250	15	20	85	2	260	2,425
Undeveloped	732	100	156	132	108	0	0	80	0	1,260	2,568
Total Length of Shore	993	1,939	226	469	638	270	340	1,200	40	2,500	8,615

NOTE: This table is based on data from the National Shoreline Study and incorporates revisions made subsequent to the draft report (136). Since data are subject to further minor change, see the final version of the referenced report.

almost the entire shoreline is beach. Critical erosion occurs principally along the ocean front from Long Island south. Shore ownership follows a pattern similar to that of beach front location. Almost all is private along the Maine and estuarine shorelines. Most of the public ownership is along the oceanfront especially in the western half of Long Island, in New Jersey and in Delaware. Most of the Federal ownership is represented by Arcadia National Park in Maine, Cape Cod National Seashore in Massachusetts, Fire Island National Seashore in New York, Assateague National Seashore in Maryland and a number of wildlife refuges, all administered by the U.S. Department of the Interior.

Some limitations on the solution of coastal erosion and tidal flooding problems are severe. For the most part the forces of nature are so great, and the limitations of the region's coastline are so significant that the region has no really complete solution. There are, however, known techniques to be discussed later for minimizing these effects. Two major problems in so doing are high costs and the "indivisible" nature of most corrective measures. The scale of most of these measures and the difficulty of the solver reaping the full benefits--or being assessed fully for undesirable external effects--makes it necessary that effective sollutions be implemented by a larger sector of the public as a whole. This has been accepted as a role of government with cost sharing formulas generally varying in relation to how widespread or public the benefit is. When a section of the coast is intermittently held by a succession of private and public landowners, difficult problems arise in developing an equitable cost sharing pattern. Similar problems of indivisibilities, however, have been resolved inland. Examples are sewer assessments and education taxes.

Location. With the foregoing in mind, it is possible to visualize the type of location which would be most vulnerable to storm and erosion damage. It would be located--

- In a large urban center.
- In an area with minimal resistance to erosion.
- At low elevation at the end of a funnel-shaped estuary.
- At the mouth of a river with heavy and rapid runoff.
- In an area with a substantial tidal range.
- A little to the right of the path of a storm's center as seen from above.
- Opposite a long fetch of reasonably deep water.

This is not a bad description of Providence, Rhode Island.

Figure U-15 shows the estimated magnitude of damages in 1970 prices of a recurrence of the tidal flood of record for each area. As mentioned earlier, critical erosion occurs in many places, but most of it occurs along the ocean front from Long Island south.

Time Characteristics. As has been already stated, essentially all inundation and much severe erosion occurs during storms. The worst storms hitting this region are hurricanes. They usually occur in August and September at a frequency of about 10 years. Other storms can occur anytime throughout the year, but they are usually worst from the late Fall through early Spring. There is no evidence that the magnitude, location or frequency of storms has, or will, change much over the years. However, there is considerable evidence that the value of man's coastal property subject to damage is increasing greatly.

To provide the necessary defined basis for analysis, two types of storms are frequently used. Since some later analysis is keyed to these two types, a brief description of each is given below. The first, "the storm of record", is simply the worst storm known to have actually hit the impact area under consideration. The other, "the standard project storm", is more useful to the analyst, but is not so easy to define. Stated simply, it is a consequence of the most severe combination of meteorological conditions considered to be reasonably characteristic of the region.

Parties Affected. Storms impact on the various users of the coastal zone to markedly different degrees. The following are arranged in generally decreasing intensity of impact.

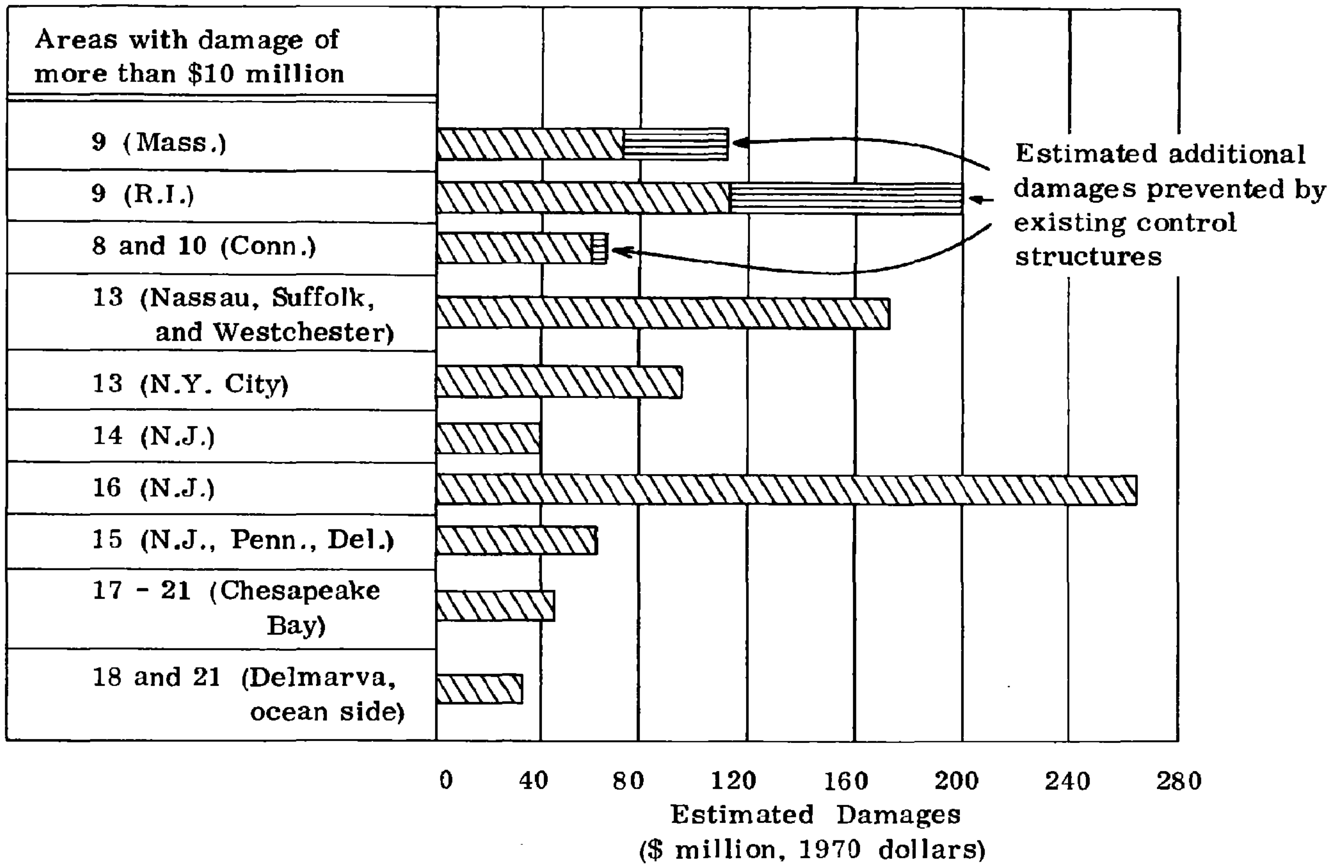
The greatest impact is upon coastal property especially in urban areas. Structures can be damaged or destroyed, subway systems can be flooded and roads and bridges can be destroyed.

Not only can fishing boats, gear and dock facilities be damaged or destroyed, but great storms can have important effects on shallow water coastal ecosystems. As previously mentioned a breached barrier beach or plugged inlet can drastically change the ecology of an entire lagoon and associated wetlands system. Storm induced sediment movements can have gross mixed effects.

Storms can greatly damage pleasure craft, alter beaches and destroy recreational facilities.

During storms combined sewer systems discharge untreated wastes into nearby water bodies. In extreme cases they might produce significant public health problems. Some of this damage is mitigated, however, by the greatly improved dillution and flushing characteristics associated with storms.

Shipping channels can be filled with sediment and the ships



ESTIMATED DAMAGES FROM RECURRENCE OF TIDAL FLOOD OF RECORD

SOURCE: Based on estimates from the U.S. Army Corps of Engineers

FIGURE U-15

themselves can be damaged in port along with extensive port facilities. Coastal airports can be inundated. The extraction of non-living resources is probably affected less, but if offshore oil and gas production is started in this region, as many predict, the offshore facilities would be vulnerable to storm damage.

Solutions. The identification of solutions is organized below in a way parallel to the earlier treatment of causes. The general idea is, knowing the causes, to see what can be done to minimize their effects by responding to the forces of nature, improving the characteristics of the impact area and overcoming special limitations on solutions.

Not much can be done to respond to tides, but something can be done to respond to the other two principal forces of nature, storms and littoral drift.

Proposals for breaking up or deflecting hurricanes could have fruition before the year 2020. The effects on minimizing the problem would be very great. Until there is some major technical breakthrough, however, other means will have to be used. The effects of inland runoff on coastal areas can be minimized through various well-known devices which retard runoff. (See Appendix E on flood control.) Timely warning can permit a mobilization and possibly a partial evacuation. During the mobilization phase, organized preparatory steps can be taken. These steps include such things as cleaning and tiedown of potential wind blown missiles, boarding up, and removal of vessels and pleasure carft. A complete or partial evacuation of the impact areas could be conducted.

These measures are largely credited with greatly reducing the extensive damage to the Mississippi Coast during Hurricane Camille in 1969. Conversely, the lack of these measures greatly magnified the effects of this same hurricane when it hit very unexpectedly in Virginia.

Groins are useful in minimizing the erosion effects of littoral drift. They are a direct and generally permanent solution, but by causing sand to accrete, they can cause a corresponding undernourishment and erosion of the downdrift area. If downdrift areas are less important than the reach protected, and if the external effects on downdrift interest can be accommodated, groins are often an excellent solution. A navigation structure, such as a jetty built to protect an inlet channel, can also cause sand to accrete on one side and erode on the other. A common solution is to remove the sand on the accreting side by pumping or dredging and redeposit it on the downdrift side.

Where an adequate supply of sand is available at an economic distance, and where ecological side effects are adequately known and found to be favorable or minimal, renourishment is usually the best solution. Until recent years, most sand for this purpose was obtained very economically from the lagoons which usually back up the barrier beaches so common from Long Island southward. After ecological examination and close coordination with the Fish and Wildlife Servie and designated state agencies, some of the needed sand will come from the lagoons. However, concern for ecological factors and the limited quantity of this sand will increasingly shut off this source.

Sand for renourishment can also be trucked from inland areas, but this solution is becoming more and more unappealing for many reasons. The costs are potentially high economically and environmentally. The sand and gravel industry has given considerable emphasis in recent years to minimizing or reversing environmental side effects; however, ecological and aesthetic damages are still potentially significant as are the related environmental problems of congestion, noise and great wear and tear on usually unsophisticated coastal road systems. For reasons such as these, in the last few years many of the communities around Boston have barred the excavation of sand and gravel, with a few exceptions, from their area. If the renourished beach is to remain reasonably stable, the distribution of grain sizes must correspond to that common to the beach in question. Inland sources, being the product of different geological sorting processes, usually are inadequate. Even when these possible difficulties can be overcome, there is the more significant problem of quantity. Because many inland sources have been exhausted and many more have been closed on environmental, aesthetic or nuisance grounds, the National Sand and Gravel Association predicts that a critical shortage of sand and gravel to meet burgeoning construction requirements will occur within the next two decades and probably sooner in metropolitan areas.

Possibly the best place to obtain the needed sand is offshore. Extensive sand surveys in recent years have uncovered major deposits situated at economical distances from many major beaches.

Dredging can be accomplished in such a way as to leave or not leave holes offshore, depending upon which configuration is found to be the more desirable. Probably holes will benefit fish by providing protective habitat, but additional study is needed (33). Increasing the offshore depth decreases its usefulness somewhat as an energy dissipator. However, this effect can be minimized if warranted by judicious selection of the offshore borrow area. The net effect of moving offshore sand onto the beach should be an improvement in the capacity of the beach as an energy dissipater.

Technologically in tests at Sea Girt, New Jersey, the Army Corps of Engineers has demonstrated the general feasibility of pumping sand from offshore. Recently a contractor was awarded a $614,000 contract to use an underwater crawlercutter to rebuild a 1.3-mile stretch of a Florida beach with ocean sand. Although costs were nearly 50% higher than the costs of obtaining the sand from nearby riverbeds or islands, ecological considerations were overriding (125). These costs can be expected to drop sharply as tehcnology and competition improve.

Whatever method of renourishment is used, it is important to realize that this method is a form of periodic maintenance which can be justified against more permanent solutions on the basis of annualized cost. Because of the vaguaries of nature it must be expected that some individual renourishment projects will erode away much faster or slower than predicted.

A second major class of solutions lies in improving the characteristics of the impact area. The principal characteristics which can contribute to the problem have been identified earlier as waves, configuration, resiliance and human values. Ways to improve some of these characteristics are developed below.

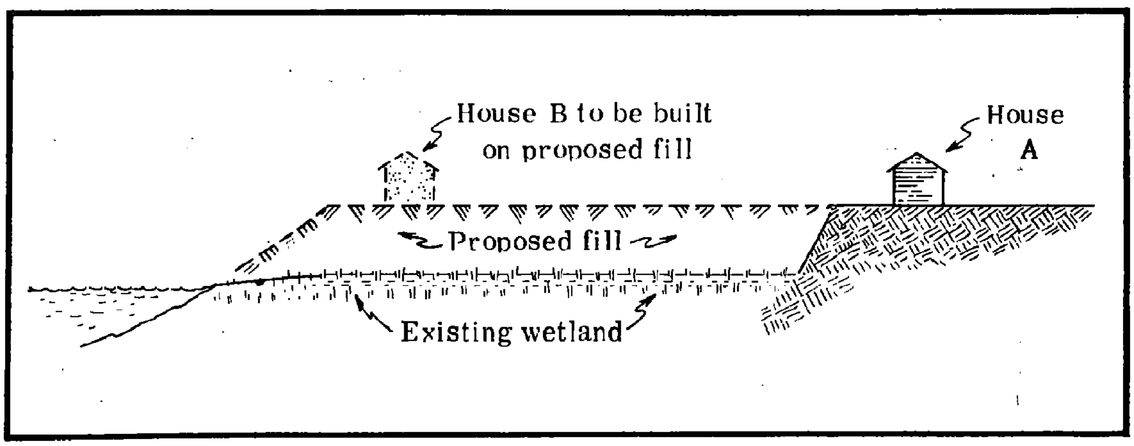
The energy of waves can be dissipated by the construction of offshore bars and breakwaters.

The effects of unfavorable coastal configurations can be reduced on the shoreline by improving the beach profile so that it can better dissipate wave energy and by providing special protection to valuable locations of known high impact. Groins, for example, can arrest litoral drift and thus cause a renourishment of the beach with sand. 1/ Groins are a local solution, however,

1/ Although not particularly classified as an erosion problem, the capability to move large quantities of sand to selected shoreline locations introduces a significant opportunity in the field of outdoor recreation. Even where, or perhaps especially where, erosion is no particular problem it may become very desirable to place sand on these shorelines to create new beaches or greatly elongate or deepen those already existing. Likely locales would be in the vicinity of large urban concentrations where water quality and other factors would not otherwise limit the locale's usefulness for beach recreation. For example, the recreational usefulness of much of the shoreline of Long Island Sound is greatly diminished by the pebble, shingle and gravelly texture of the beach. Similarly as recreational pressures increase on the ocean front in future years it may be that the usefulness as bathing beaches of parts of the shoreline of bays behind the barrier beaches can be greatly increased by judicious applications of sand after careful environmental background investigations. The potential is illustrated by the fact that from the eastern tip of Long Island to the southernmost Virginia limits of the NAR, the length of the backbay shoreline even excluding Chesapeake Bay, is more than twice the ocean coastline. At present this shoreline is almost all wetlands and mud flats. At least some might be developed as beaches without much ecological damage.

since drift arrested at a particular place will be replaced by sediment eroded elsewhere if the wave energy responsible for the transport has not been absorbed or dissipated. Protecting cliffs or bluffs from destruction with riprap or sea walls is also a local solution. Unless a means of providing sediment for transport is established at the same time, erosion will move to a different point, not too distant along the long shore current.

Possibly because the advantages of a flat beach as an energy dissipater have long been recognized, it is frequently stated that wetlands provide substantial protection to the shoreline behind them. This proposition is often advanced in the context of evaluating proposals to fill wetlands. The proposition badly needs definition. Consider this sketch.



Now it is certainly true that the wetland provides a desirable buffer effect for House A under existing conditions. However, it is not true that the proposed fill would destroy this effect. In fact from the point of view of its protection from storm effects, the contrary is true-House A will benefit from the fill.

Consider House B. It is true that it will have less protection than House A had either before or after the fill. However, this disadvantage can often be offset by protective works at the shoreline. The costs of these works should be included in the project and they may or may not influence its desirability.

Furthermore wetlands are almost always situated on back bays or other protected areas and are thus spared most of the major direct storm attack. If this were not so, they would not long exist in storm frequented areas.

This discussion in no way is intended to make a case for either preserving or filling wetlands. It does suggest, however, that in such considerations the buffering effects of wetlands is not a major argument. The case for wetlands lies more substantially in their ecological, recreational, aesthetic, and valley storage values cited earlier under "Conservation and Wetlands."

Moving inland, much can be done to preserve and improve dunes. Programs can be developed to include preservation, improvement and maintenance.

Under preservation, steps would be taken to see that the public understands and respects the importance of dunes. Passages through the dunes would be delineated and controlled. Public trampling or building on the dunes would be restricted.

Under improvement, the height of the dunes would be built up. This can be done in a variety of ways. One quick method is to import sand of a grain size distribution observed to be stable nearby. Delaware is pioneering a bulldozer approach. The dozer piles up sand from the leeward side of the dune leaving a sharp cut there. Wind effects reportedly move additional sand quickly to fill in the unnatural temporary depression. Picket sand fences properly spaced can trap wind blown sand and build up dune heights, often in more than one layer. There is room for considerable imagination here. For example, the placement of salvaged Christmas trees are reported to be excellent for this purpose. This could provide the basis for an annual community environmental improvement project involving groups such as the Boy Scouts.

Under maintenance, the built-up dunes should be stabilized preferably with vegetation. Currently American beach grass (Ammophila breviligulata) is the best planting. It can be obtained on site by selectively breaking up clumps growing in rearward areas. Much research can be done on this and other binding and stilling plants by selection and breeding to improve their environmental hardiness. Dune plantings have been shown to be very responsive to fertilizers. Once they take hold, their extensive root structures protect the dune. The aboveground vegetation entraps windblown sand and thus further increases the height and stability of the dune. The U.S. Department of Agriculture's Soil Conservation Service is currently doing much research on dune stabilization methods at its Cape May Plant Materials Center (132).

In special cases, the resiliancy of the shoreline can be improved by rock, bulkheads and sea walls. Although very expensive these devices are often the best solution where high valued land uses must crowd the coastline. Examples are some coastal highways, airports, ports and other industrial and urban facilities.

The greater the human values associated with a coastal stretch the more extensive is the effort justified to protect that coast. However it seems clear that many facilities do not have to hug the coast. To minimize the great cost of protection, the principles of flood plain management can be applied. The U.S. Water Resources Council is currently sponsoring research on the possible application of these techniques to coastal area.

Under this approach the limits of areas subject to inundation are delineated, the information is disseminated and appropriate control measures are instituted. Of course it is simplistic to think that all problems can be overcome by a "keep out" approach; many important uses such as those cited above are already located right on the coast and must remain there or forego benefits many times greater than the cost of protection or the acceptance of periodic damage. However, flood plain management techniques, over time, can limit coastal facilities to those whose presence there is truely essential.

Another technique applicable in special cases is "floodproofing". Under this approach damagable facilities can be located above the ground floor and foundations can be reinforced to withstand predictable impacts.

Not to be overlooked in any consideration of human values is the importance of preserving and improving ecological values. Unfortunately many of these values are so widely distributed over extensive wetlands that significant protection is probably impracticable. One clear exception, already cited, is the protection of barrier beaches from storm-induced breaching because of the significant, possibly undesirable consequences such breaching can trigger in the lagoons behind the barrier beaches.

A third major type solution lies in overcoming special limitations. Two special problems mentioned earlier are the high costs of solutions and the difficulty of distributing these costs to the beneficiaries because of the indivisible nature of many solutions, the generally widespread nature of the benefits and the presence of some externalities. The problem of costs can be minimized by additional research on methods and careful analysis to insure that the costs are incurred in places where the benefits are commensurate. The problem of cost sharing has characteristics which classically identify with government involvement. The problem is by no means unique to coastal protection. It has parallels in many governmental functions such as road construction and flood control. The more widespread the public benefit, the higher the public share of the cost has typically been. The beneficiaries of coastal protection are the users of the coast whether they reside there or visit it.

The costs of these solutions varies greatly. An improved warning, mobilization and evacuation system should not cost too much, especially if local civil defense systems are exercised. Extensive relief operations required in the aftermath of real disasters can be very costly, but governments and volunteer groups have long demonstrated their willingness to contribute.

The cost of improvements depends upon the magnitude of the project and the avilability of materials. For the construction of most beach improvements, experience indicates that costs may range up to $250 per linear foot of coastline. Groin construction may cost in excess of $100 per linear foot depending upon the wave and beach dimensions. The beach renourishment project in Florida mentioned earlier ran bout $90 per linear foot. Revetment costs are more expensive than beach renourishment and can in more exposed areas cost in excess of $500 per linear foot. A degree of economy can sometimes be achieved by using excess material from a nearby construction project thus affording savings on both jobs. For example, a community could have excavated rock dumped at the toe of its seawall thus providing inexpensive and important maintenance. The cost range of improvement projects at individual sites in this region is expected to be contained in the forthcoming National Shoreline Study (136).

Massive hurricane flood control structures can be very costly. For example, the Fox Point Barrier, which was completed in 1966 and which protects a major portion of Providence, cost about $17 million and the proposed Lower Narragansett Bay Barrier has an estimated 1970 cost of about $133 million. Costs for providing hurricane tidal flood protection for Long Island the adjacent port of New Jersey, exclusive of the New York Metropolitan area, are estimated at over $200 million in 1970 dollars.

Federal participation is usually allowable when project solutions are beyond the reasonable capability of local authorities and when the benefits are public and exceed the cost. The cost of the study of eligible projects is born completely by the Federal government. Up to half the cost of feasible protective works for breach erosion control along publically-owned shores is Federal, except in the case of parks and conservation areas which meet certain requirements. In these instances up to 70% Federal costs are authorized. Privately-owned shores are generally ineligible for participation except when their protection is beneficial to a nearby public use or when the benefits to the private shore are incidental to the project. The non-Federal costs are usually met by the state and/or the shoreline locality under different state formulae. Table U-16 summarizes state cost sharing policies in this region.

Many of the solutions proposed can provide a net benefit to ecosystems. However, the possibility that solutions could produce damage to down drift users must be carefully evaluated and provided for either in the design or by acceptable means of mitigation. Throughout this analysis ecological side effects have been constantly identified and solutions have been developed with these considerations in mind. Two of these effects mentioned are: damage to ecosystems by climactic events of nature such as complete altering of back bays, and effects on ecosystems in borrow areas which can be minimized or reversed by study of the location, time, desired configureation of the area and the reestablishment of benthic life.

Especially when very large undertakings are being considered with important population centers and potential disaster conditions involved, benefits may be expected to be high--and for justified projects they are. The existing $17 million Fox Point project near Providence is expected to prevent about $86 million of the estimated $180 million damage which would result from a recurrence of the tidal flood of record--the 1938 hurricane. A recurrence of the tidal flood of record--actually two storms: the 1938 hurricane for most of Long Island and a 1960 storm for western Long Island--would inflict an estimated $320 million in 1970 dollars in damages on the Long Island-adjacent New Jersey area, exclusive of the Metropolitan New York area. The standard project storm for New York Harbor has been estimated to cause about $2.5 billion in direct damages in 1958 dollars. Of course, no foreseeable plan could be expected to eliminate all these damages, but the potential for very great benefits is clearly evident and is the subject of a number of studies completed and in progress. Just the provision of emergency plans for evacuating and protecting the New York City subway system from inundation and a disastrous loss of life could produce tremendous benefits some day.

Indirect benefits are, by definition, harder to quantify but they are probably very large. In a preliminary estimate, the Army Corps of Engineers predicts indirect damages from the standard

TABLE U-16

SUMMARY OF GENERAL POLICY OF
STATE PARTICIPATION IN SHORE PROTECTION PROJECTS

State Participation - Portion of Non-Federal Share	States
	<u>Federal Projects</u>
100%	Delaware (Each project must be approved individually by the State Legislature)
50%	Massachusetts, Connecticut
70%	New York
75%	New Jersey
1/	Maryland
No specific programs	Virginia, Rhode Island, Maine, New Hampshire
	<u>Other Projects</u>
100%	Delaware (Each project must be approved individually by the State Legislature)
67% 2/	Connecticut
50%	Massachusetts, Rhode Island
75%	New Jersey
70%	New York
a/	Maryland
No specific programs	Virginia, Maine, New Hampshire

1/ Interest-free loans to municipalities made by State of Maryland.
2/ For publicly owned shores. For privately-owned shores the State pays one-third.

SOURCE: (136)

project storm, in New York Harbor at about $2.4 billion in 1958 dollars. How much of this can be economically prevented is currently being studied. Indirect benefits include possibilities for encouraging desirable development, increasing shorefront values, increasing tourist trade and generally enhancing the shorefront environment and ecology.

Most organizational consideration have already been addressed during discussion of other aspects of the problem. It has been seen that within the U.S. Government, the responsible agency is the U.S. Army through its Corps of Engineers. Considerable coordination is accomplished with the National Oceanic and Atmospheric Agency on fish and wildlife values and with the Department of Housing and Urban Development on residential and urban values. At the state and local levels cost sharing formulae have usually been worked out. Projects have not been considered by the U.S. Government unless they have been requested by an individual or by local or intermediate levels of government.

A complete listing of authorized Federal projects and authorized Federal survey studies in progress in this region will be contained in the forthcoming National Shoreline Study (136).

Solution effectiveness is summarized below in terms of the three basic overall NAR objectives. Not included in them is the added wellbeing benefit of saving substantial grief and loss of human life.

Since all projects must stand the test of benefit cost analysis, however incomplete the evolving knowledge of this tool may be, it follows that most net benefits derived fall into the national efficiency account. Recent and ongoing studies imply that these benefits could be substantial, possibly in the billions. The overall total annual benefits of feasible solutions are currently unknown although they have been calculated for numerous individual projects. Much information is available at the appropriate Corps offices, but it is below the scope of detail of this regional framework study.

Although the principal benefits are economic, substantial environmental benefits can accrue as well particularly through the protection of ecosystems against disasters from which they have demonstrated an inability to recover rapidly. Careful attention during the formulation of solutions must also be paid to ecological values because some of the larger projects have a potential for ecological damage which can be controlled, reversed or mitigated by careful design and review.

Even when Federal surveys indicate that remedial measures are not economically feasible and thus ineligible for Federal aid, they can be undertaken by state or local interests in a regional development context. These projects can often benefit from the technical evaluation produced in the Federal survey.

REGIONAL SUMMARY

SUBREGION A

Subregion A is the northernmost portion of the North Atlantic Region and is wholly contained within the State of Maine. The entire coastal portion of this subregion is included in Area 5 and extends from Calais on the north to the mouth of the Androscoggin River on the south.

The subregion is disucssed here in terms of its characteristics, major coastal uses, major coastal problems, and major prospects and potentials.

General judgements as to the relative importance of the selected problems in the subregion (Area 5) are outlined in Table U-17.

TABLE U-17

PROBLEM PROFILE IN SUBREGION A

Problem ✱ Highly significant * Significant ● Relatively insignificant	Living resources	Conservation of wetlands	Non-living resources	Water pollution	Thermal effects	Solid wastes disposal	Recreation	Marine transportation	Coastal erosion and tidal flooding
Area 5	✱	●	*	✱	*	●	*	*	●

Area Characteristics. This portion of the NAR coastal zone is characterized by a rugged, rocky shoreline with many deep, narrow inlets and coastal islands. There is a high tidal range accompanied by strong coastal currents and high flushing rates for the bays and estuarine areas.

The waters of the area are cold in comparison to the more southern parts of the region with April-May seawater temperatures usually between 45°F. and 50°F. in the Boothbay Harbor locale which is in the southern part of the area.

There are three major rivers flowing into these coastal waters. At the Northeastern extreme is the St. Croix River which flows into Passamaquoddy Bay. Midway in the area the Penobscot River enters. The estuarine area associated with the Penobscot is extensive, very scenic and, as will be discussed later, relatively heavily modified, primarily by water pollution.

The third major river borders the area on the south. This is the Kennebec River. Here, as with the Penobscot, there is an extensive estuarine system associated with the river, and here again, water quality is a major factor.

There are also a large number of smaller rivers and streams flowing into the coastal and estuarine waters of the area. These streams coupled with the many bays and inlets create a variety of estuarine and wetland regimes, rocky shores and some sandy beach and make this the most naturally diverse area of the entire North Atlantic Region coastal zone.

One of the characteristics which makes this area outstanding is the distinct lack of major urban areas and concentrations of population. It is the least densely populated area within the NAR coastal zone.

There are five counties in the area. In total the population of these counties has decreased from 135,104 in 1950 to 132,100 in 1968 (57). While this does not indicate directly what the coastal population changes were, there are no major population centers in the area that are not on the coast and, of the nine major towns with populations over 2,000, five showed a decline in population between 1960 and 1966. Informal reports of the results of the 1970 census indicate that this trend of declining population is continuing, especially in the more northern sections, which are distant from southern markets, have severe winters and rely heavily on a declining fishery for an economic base.

There is a significant increase in population during the summer months, particularly in the coastal towns due to an influx of tourists and recreation seekers. However, even in this case, the more northern portions of the area do not experience as much of this increase.

Major Coastal Uses. The species of living resources of commercial importance in this area include crustaceans, shellfish, finfish and seaweed.

Lobster is by far the highest value fishery product harvested in these coastal waters. The total value of the catch in Maine in 1969 was in excess of $16 million. Of this total, $12.4 million were associated with the lobster landings in Area 5.

Second to lobster in value is the catch of Maine shrimp. The value of all Maine landings of shrimp in 1969 was $3 million with $2.2 million of this occuring within Area 5.

In the shellfish categories the soft shell clam leads all other species and is the only really economically important shellfish in the area.

Of the commercial finfish, ocean perch and herring comprise the bulk of landings in Area 5 with a 1969 value of $1.5 million and $.9 million respectively.

Other living resources harvested in the area are sea moss, the source of carrageengel, and bloodworms and sandworms for bait. Sea moss is used in many foods and medicines as a stabilizer.

There is also an extensive sport fishery in the area. The same species listed as commercially important are sought by the sport fisherman. The "deep sea" fishing party has been an important part of a Maine vacation for many years. While the "party boat" activity is of major importance, there has been a growth in the use of private boats, surf casting and even scuba diving over the past few years and the trend appears to be continuing.

Lumber and wood for pulp and agriculture are also major activities in the area but are not directly related to the coast and will not be discussed here.

Another major use of the coastal zone is recreation. Due to its natural characteristics and its unspoiled nature this area is attractive for a large number of recreation activities, primarily sightseeing, boating, camping, hiking, picnicking, beachcombing and fishing. A number of relatively small beaches are used for swimming and sunbathing, but swimming is limited because of the cold waters.

There are twelve state parks and memorials along the coast. These offer a variety of facilities and opportunities for recreation ranging from small, single-purpose historic and scenic sites to a full complement of facilities for camping, swimming, fishing and picnicking. Use of these facilities is increasing rapidly. For example, Camden Hills State Park went from 83 thousand users in 1964 to 176 thousand in 1965. (58)

Acadia National Park is located in Area 5. This park of over 30,000 acres is located on Mt. Desert Island and contains two large well-developed camp grounds, two swimming beaches with bath houses, miles of hiking trails and roads for sightseeing. This park experiences heavy use from the last week of June through Labor Day. Ten private camp grounds on the island have a total capacity which exceeds that of the national park and are often preferred, particularly by trailer campers, since they offer utility hookups. Some camp grounds on the island are having difficulty in providing adequate sewage and water supply.

While public recreation facilities experience heavy and growing demand, the bulk of recreation activity in the area is conducted in private facilities. Summer camps and homes abound in this coastal area and the numerous harbors are extensively used by private boats in the sourthern part of Area 5.

While the presently available facilities are well-used, there is an opportunity for further recreational development in the area. The major problem with attempting commercial development is the short season for coastal recreation in this area. Due to its northern location, the summers are relatively short. In addition, the area is distant enough from the major population centers to preclude most short period use, for a day or weekend. Consequently, very few people seek out this area for recreation except during vacations of a week or more. Persons entering the recreation industry here must realize their income in a short season. (This is changing as snowmobiles increase in popularity. Acadia has an extensive snowmobile trail system).

Another factor in the northern half of this area which has an influence on recreation use is the lack of "destination" facilities. The large number of tourists and recreation seekers entering this area tend to use it as a transporation corridor to reach other areas in Canada. Bypassing this area are two ferry steamers, the Blue Nose and the Prince of Fundy which sail to the Maritime Provinces from Bar Harbor and Portland respectively. Both of these ships have been operating at or near full capacity. This diversion of the flow of recreation seekers lessens the demand for recreation related facilities in Area 5.

Sport fishing, discussed briefly under the extraction of living resources, is a significant component of the recreational resources of this coastal area. Surveys of sport fishing along the entire Maine coast have shown a close relationship of sport fishing to the proximity to urban population centers. Thus the salt water sportfishery is relatively unexploited in the relatively unpopulated northern part of Area 5. Further development must be matched closely with the growth in demand. (7)

The entire coastal portion of Area 5 is heavily mineralized by a varying combination of heavy metals. Among these are iron, zinc, chromium, nickel, lead, cobalt, manganese and copper. A history of sporadic mining explorations and actual operations goes back many years. In fact, during 1880's, there was a mining boom complete with a stock exchange in the local area.

At the present time, only one mining operation exists. This is an open pit mine on the edge of Penobscot Bay at Cape Rosier from which copper and zinc ore are being removed. The ores are concentrated on sites and then shipped out of the area for refining. Current daily production from this mine is approximately 700 tons of ore containing 6% zinc and 1% copper. The operation employs about 75 people. (10). The mine is expected to cease operation in 1972.

Continuing environmental problems have accompanied the operation. Problems are associated with the noise of operations, blasting, drilling and trucking; water pollution is caused by silting and by drainage of toxic metals from the mines; and scenic disruption is caused by the open pit and the deposition of wastes. The extensive amount of pumping to drain the pit has also tended to lower ground water tables and allow salt water to intrude into local ground water supplies.

A number of proposed sites have been proposed for additional mining operations in the area. However, the ores are relatively lowgrade and the viability of such operations is entirely dependent upon favorable metal prices. Most of such ore bodies are of marginal value, at best. If the costs associated with environmental protection are relatively high, the incentive for mining will be low.

A substantial amount of sand and gravel mining is also conducted in Area 5. This is generally from on-shore deposits scattered along the coast and is used in construction in nearby areas. Investigations have shown that offshore deposits in Area 5 are of low quality and run more to silt than good quality sand.

There appears to be high probability of gas and oil resources offshore in the Gulf of Maine. If this is the case, and they are developed, this activity will have a strong influence on the kinds of development which occur throughout the area.

A final non-living resource use related to the coast is the use of coastal water. The mining operation at Cape Rosier uses extensive amounts of salt water to concentrate its ore. This water is recycled in the process to help control pollution.

Of much greater significance is the use of coastal waters for cooling, particularly in power generation. While this use is limited at present, it will likely increase significantly as power companies seek out sites for new plants with adequate cooling waters in the northeastern United States.

The use of the coastal waters in Area 5 for transportation and shipping is limited primarily to the fishing industry at this time. (Even the ores from the Cape Rosier mine are shipped out to refineries by rail). There is a lack of developed docking and freight handling facilities in the area.

The major reasons for this are the distance to the markets further south in the region and the fact that major ports exist in these heavily populated market areas.

However, as vessels are designed and built in larger and larger sizes the harbors to the south will become inadequate, primarily because of the draft requirements of such vessels. The deep-water inlets and bays available in this area have characteristics which will make them more desirable for port development.

Of particular importance to this area is the proposed development of a major port at Machiasport for use by supertankers. There is a great controversey about the desirability of such a development, particularly when it is coupled with the development of a refinery. The major concern is for its potential effect upon the presently unspoiled natural beauty of the area, together with the potential for oil spills and their unkown long-term ecological effects.

In the coastal zone of Area 5, urban and industrial development has been minimal, in keeping with the loss of population and low level of economic activity in the area. Extensive portions of the coast remain undeveloped at this time.

One of the main reasons has been that a small number of wealthy families have had substantial land holdings and summer estates. As these holdings are handed down through the succeeding generations ownership is becoming more diffuse, and heirs are finding it impossible to maintain large holdings under today's financial pressures. Consequently, the pattern of land ownership is changing to smaller, more numerous holdings. This will tend to remove the control on development and significant changes in land use will likely occur.

As in all areas there is the need to use coastal waters for waste disposal. This use of the coastal zone is largely unorganized in Area 5. Many of the coastal communities rely upon septic tanks and cesspools for domestic waste disposal. Others provide collection systems with minimum of treatment prior to discharge into the coastal waters.

There is a considerable waste load entering the coastal waters from inland. The waters of the Penobscot River and the Kennebec River are carrying heavy waste loads when they become estuarine. Most of these wastes originate from inland activities such as pulp and paper processing, agriculture and food processing, and domestic waste disposal. The majority of these wastes are from identifiable point sources. However, this means not that non-point sources are unimportant, but that they are not well known.

Major Coastal Problems. Almost all of the 1900 miles of the exposed shoreline of Area 5 is ledge outcrops or massive boulders. Only about 10 miles can be considered as beach. Consequently, with very minor local exceptions there is no coastal erosion or tidal flooding problem in the area. The State of Maine has no program, and no Federal projects have been authorized (136).

The two major problems in the coastal zone of this area are unemployment and water quality in relation to affected uses. Washington County is experiencing an unemployment rate of nearly 14%. This is accompanied by low-average incomes and a loss in population as people seek employment in other areas. The other counties in the area are also facing relatively high unemployment situations and generally declining population.

The coastal water quality problem results principally from pulp and paper processing, mining, agriculture and food processing and municipal wastes.

The pollution of coastal waters has a significant impact on the fishery of the area. In 1969 for example, 71,000 acres of shellfish beds were closed to fishing because of bacterial pollution in Maine (167). However, most of this closure is in Area 6 to the south.

Also of great concern to the fishery industry is the effect of pesticides upon the commercially important species. Lobsters, crabs and shrimp are closely related to many of the pests which the pesticides are designed to kill. For example, a lindane solution of one part in five billion will kill lobsters and shrimp; commonly available household sprays contain up to one part in one million. There have been numerous cases of total mortality in lobster pounds where pesticides were used (38).

In addition to the lethal aspects on certain species there is the danger of the accumulation of residues of pesticides in the tissues of commercial species rendering them unfit for human consumption. Care must be exercised in the handling of pesticides because they are extensively used in the forestry and agricultural industries.

Waste from sawmill operations such as sawdust and bark have been carried into the estuarine areas and deposited in areas where they appear to have smothered shellfish. It has been observed that the overburden on a number of shellfish "graveyards" was a layer of sawdust.

Marine scientists are also finding that the sawdust does not decay as would be expected, but rather tends to mineralize. Combustion tests show the material to be non-flammable and long-lasting. (Perhaps it may have commercial value).

The heavy metals and associated wastes due to past and present mining operations are also of concern to the fishing industry. Toxic metals are found in sediments near mining sites that have been inactive for several decades indicating that they tend to persist over a long period. Concentrations of metals in shellfish in the area of Cape Rosier have significantly increased since the resumption of mining and separating operations there. This has occurred even with special care and precaution to minimize pollution.

There are some locally severe pollution problems associated with the management of inland waters. (153) In the lower Penobscot River from Bucksport to Winterport and, at times, in the lower Kennebec River the level of dissolved oxygen drops to zero. This forms a complete oxygen block preventing the passage of fish and causes frequent fishkills. Flows could be regulated for quality and quantity to help prevent this condition from occurring. This should be taken into consideration and specified as a demand upon the inland water resources.

Major Prospects and Potentials. With the broad overview of Area 5 which has been presented up to now and particularly the preceding disucssion of major problems, the next step is to examine the prospects for the area and how these prospects relate to the objectives established for the NAR study (regional development, national efficiency, and environmental quality).

It seems evident that activities designed to increase income and the level of employment in the area will be compatible with the first two objectives. In this respect there are four areas which have the potential for major contributions to these objectives.

First, with the steadily increasing demand for electricity, the relative scarcity of acceptable inland sites for generating plants, and the availability of vast quantities of cold water make Area 5 a desirable area for siting new power plants. The tax revenues generated by such facilities are substantial and could provide some stimulus to the economy. This development would not by itself, substantially reduce unemployment; but with the prospects of relatively cheap supplies of power other industry may be induced to come into the area.

One must exercise caution, however, when drawing conclusions about solving the unemployment situation in this area by simply bringing in industry. Many of the people have seasonal occupations, have selected a generally independent way of life and are not ready or willing to change this lifestyle.

Another long-standing proposal in the power field is the Passamadquoddy Project. This proposal is to harness the power of the tidal range in Northeastern Maine and Southern New Brunswick by building tidal dams across Passamaquoddy Bay. The ecological changes caused by such a project may be of immense proportions. (However, preliminary studies related to the scallop fishery indicate an improvement in that industry would likely occur).

A second prospect for development is the potential for the development of deep water ports such as the Machiasport proposal. Together with one or more refineries the potential for economic gain to the area is large. For example, one oil company has proposed to build a 100,000 barrel-a-day refinery in the Machiasport area. It has been reported that the refinery would cost more than $150 million and employ about 350 people, not counting the construction period employment. Some people have questioned whether the economic benefits to the locality would actually be significant, and many have expressed concern over the potential impacts of oil spillage and industrialization on this aesthetically attractive, low income area. If the proposed development occurs, several oil companies would probably build in the area, again with mixed economic-environmental implications. Such development would generate a substantial increase in fresh water demands.

A third prospect which should be, and is, receiving a considerable amount of attention is fisheries management, particularly aquaculture. The fisheries industry as it now exists encounters severe economic difficulty in competing with other conflicting uses of coastal resources. The pressures for development along the coast and its use for waste disposal will continue to work in opposition to the fisheries. This does not rule out the transformation of fisheries into a more viable industry, however, major changes or alterations would be necessary.

Aquaculture could overcome this relative disadvantage. The physical nature of the coastal area and the nutrient rich waters are amenable to such an enterprize. It will require coordinated management of inland waters. Several experiments are underway now to demonstrate its economic feasibility.

A fourth prospect is the major potential for continuing recreational development. The demand for facilities grows substantially as population and levels of income grow. The relatively unspoiled coastal resources for recreation such as exist in this area are becoming more scarce in the southern portions of the NAR.

However, as previously mentioned, if these resources are to be utilized there must be an increase in destination facilities. The Bureau of Outdoor Recreation recommends a 40-50 thousand acre park which would provide this need in the northern part of Area 5, particularly if it extends from the coast to inland areas. There is a question, however, as to the potential success of such a park due to the frequent fogs which occur in the area and also because of the black flies which are so plentiful and bothersome to campers.

While recognizing the economic needs of the residents and thus the need for some development, placing Area 5 in the perspective of the overall North Atlantic Region raises a very important caution flag; this is a unique natural coastal area which is relatively unspoiled.

Several most likely development opportunities have been identified. Of these recreation and aquaculture/fishing would tend to maintain the environment. The development of a petrochemical industry would tend to significantly alter the area. The generation of power per se might have a minimal effect, although the vast quantities of heat generated <u>must</u> have an impact (not well understood) on the marine ecology. But industrial development which frequently accompanies new power sources may be detrimental to the environmental quality of the area.

SUBREGION B

The coast of this region extends from the mouth of the Androscoggin River in Maine to the southern limits of New England.

The subregion is considered herein in terms of its characteristics, major coastal uses, major coastal problems and major prospects and potentials under four geographical subdivisions related to the areas delineated for use throughout the NAR study. From a coastal point of view, it was found desirable to combine some of the NAR areas and subdivide others.

The areas and general judgments as to the relative importance of the selected problems in each are outlined in Table U-18.

TABLE U-18

PROBLEM PROFILE IN SUBREGION B

Problem ✱ Highly significant * Significant ● Relatively insignificant	Living resources	Conservation of wetlands	Non-living resources	Water pollution	Thermal effects	Solid wastes disposal	Recreation	Marine transportation	Coastal erosion and tidal flooding
Area 6	●	*	●	*	*	●	✱	*	*
Areas 7 & 9 (Mass.)	*	✱	*	*	*	*	✱	*	*
Area 9 (R.I.)	*	*	●	✱	*	●	*	*	✱
Areas 8 & 10 (Conn.)	●	✱	●	*	*	●	✱	●	*

Area Characteristics. The coastal portion of Area 6 extends from the mouth of the Androscoggin River in Maine, southwest to the border of New Hampshire and Massachusetts. This area contains a variety of physical characteristics which range from rugged rocky shoreline to sandy beaches and marsh areas.

The section northeast of Portland, principally Casco Bay, has deep rock embayments and is similar to the rockbound shoreline of "down east" Maine. While it does have at least 50 percent rocky outcrops, it is the transition zone from the rocky shore to the sand beach shore.

South of Portland the sandy beach and marsh regime is predominant. There are a number of substantial crescent-shaped beaches which have good quality sand, suitable for beach recreation. Of the 600 miles of shoreline in this portion of Maine, approximately 50 miles are beaches (136).

The New Hampshire shoreline is characterized by extensive barrier beaches in front of tidal marshes in the south and rock ledges with pocket beaches in the north. About 25 miles of shoreline are sand beach (136). The New Hampshire shoreline includes the shores of Great and Little Bays and the navigable parts of the rivers which flow into the bays (none of which are navigable much beyond eight miles inland).

The New Hampshire wetlands, considered to be very important from a fish and wildlife standpoint include about 5300 acres of salt meadows, 375 acres of salt marshes and 3900 acres of bays (136).

The three Maine counties included in this area have experienced substantial growth over the past two decades. In 1968 they had a population of about 320,000 people, approximately one-third of the total population of Maine (57).

There are about seven municipalities with a population of 10,000 or more. The Portland/South Portland metropolitan area is the largest population center in the state with a 1966 population of about 100,000 (56).

The coastal area of New Hampshire consists of Rockingham County. It ranks second in population among the ten counties of the state with 99,000 in 1960 and experienced a 41.4% growth in the decade ending in 1960. The seacoast portion had an estimated resident population of 43,000 in 1964 (80). Portsmouth is the largest coastal city in New Hampshire with a population of 28,000.

There is a significant increase in population in Area 6 during the summer due to an inflow of tourists and recreationists. The New

Hampshire seacoast in 1964 had a maximum summer population which was 88% higher than the resident population (80) and, in 1966, the three Maine counties in Area 6 had a summer population which was approximately 36% higher than the resident population (56).

The projections for Area 6 indicate a doubling of the population between 1960 and 2020. The coastal portion of New Hampshire will likely receive a proportionate share of the increase, while the Maine coastal area may gain a more than proportional share of this increase. While this last statement is conjecture, the economic situation along the coast (which will be described in the next section) indicates that this may well be the case.

Major Coastal Uses. The major economic activities in Area 6 related to the coastal resources are recreation and transportation (commercial and national defense). However, each of the major use categories does exist to some degree. The availability of information and data related to the coastal resource uses varies by use and by geographic location.

As a percentage of the total economic activity in Area 6, the extraction of living resources is small. The total value of the catch of shellfish, crustaceans, and other saltwater commercial species in the Maine and New Hampshire counties of Area 6 was about \$7.7 million in 1969 (57). Lobster and shrimp lead the field in value of landings.

Shellfish, primarily hard and soft clams are found extensively from Boothbay Harbor to Portland. South of Portland, only the Portsmouth area including Great Bay and Hampton Harbor appear favorable to shellfish.

Recreation is one of the most extensive uses of the coastal resources in Area 6. The use of the fine sand beaches of the southern sections and the many islands, harbors and bays of the northern sections is influenced by their relative proximity to the large urban areas of southern New England--primarily the Boston area. The public beaches in Southern New Hampshire are close enough to that area to experience a high day use demand as well as overnight use demand. While specific figures relating to income originated by coastal recreation were not available for New Hampshire, the 1963 income from recreation for the entire state was about \$56 million (80). The seacoast area accounts for a high portion of the state's total visitors (as well as resident population) and, consequently, a sizable portion of the income from recreation.

There are three state parks on the New Hampshire coast which have a primary emphasis on beach use--none with overnight camping facilities. There is, however, a large number of privately operated overnight accommodations in the area. It is estimated that about 8 miles of shoreline are open to public recreational use and 30 miles are used for private recreation in New Hampshire (136).

Of the 600 miles of shorefront in the southern portion of Maine only about one percent is in public ownership. Most of it is devoted to recreation. Included are several popular public beaches, including Old Orchard, Wells, Ogunquit and Kennebunkport and State parks with excellent facilities for day use. There are also approximately 522 miles of shorefront which are used for private recreation (136). Included in this private sector are 34 privately operated camp grounds. It is clear that throughout Southern Maine, the principal use of the shorefront is for recreation.

The rate of growth in use of facilities over the past decade and the projection of future demand indicate that there will be a continuing development of recreation related facilities in Area 6. There will necessarily be a mixture of private and public development. Public facilities will experience increasingly dense use and this will require continued expansion and improvement of the existing beaches.

The principal non-living resources of Area 6 are sand, gravel and water. There are minor deposits of other non-metallic minerals indicated throughout the area (78) but they are not significant and the development of extractive industry is not expected.

Up to the present time, and most likely for some time to come, the greatest activity has been in the mining of sand and gravel. While a significant portion of such material used in construction has come from on-shore deposits, the pressures for preserving environmental quality are forcing the industry to turn its attention to the possibility of offshore mining. A primary demand for sand is related to beach improvement and maintenance. Most of the material used in this manner will be dredged from nearshore deposits and from the bottom of selected harbors where improvements for recreational and commercial navigation are warranted. The need for beach maintenance is especially prevalent in the southern portions of the area, where the littoral drift creates a net loss of material from the extensive beaches to offshore areas (136).

The other principal non-living resource of importance within the area is water. The use of saline water, mainly for power cooling, is limited at this time, but is expected to increase substantially through the next 50 years to meet the power demands of the area. There will be an increasing pressure to locate new generating capacity in coastal areas to take advantage of the vast quantities of water available for cooling.

The relatively cold coastal waters of the area and its proximity to the New England Road centers make this area desirable for such development.

Deep draft port facilities in Area 6 exist in Portsmouth, New Hampshire and Portland, Maine. Most of the other ports and marinas are located on rivers near their mouths. The inland limit for river navigation in this area is about 8 miles.

The major commodity of commercial importance to transportation in the area is crude petroleum. Portland has the bulk of the petroleum handling facilities. It is the starting point of three pipelines to Canada and one to Bangor. Water borne commerce in the area increased at an average annual rate of 5% from 1949 to 1967.

Portsmouth, with fewer facilities and less depth, has only about 7-8% as much tonnage as Portland. It experienced an average annual growth rate of 4.8% between 1949 and 1967, but has been growing at a decreasing rate over the past 10 years.

The naval shipyard at Kittery, Maine, which shares the Piscataqua River with Portsmouth, has been a major employer in the area for many years, but it is now being phased out. There is concern for the economic consequences of this action.

The remaining facilities in the area are devoted primarily to recreational boating. This use is increasing in keeping with the growth of recreational demand.

The use of coastal lands in Area 6 is mostly devoted to facilities related to recreation. There are many fine summer homes all along the coast. Commercial and industrial development have tended to cluster in the major population centers of Portsmouth and Portland or are back from the coast.

Commercial-industrial development is much in evidence in Casco Bay in the Portland Area, particularly related to the storage and shipment of petroleum. Plans are now in existence to develop Long Island in Casco Bay for a major oil handling facility and refinery. Concerns over the potential for oil spills and pollution of the Bay waters as well as environmental concerns in general is holding up the project at the present time.

The possible development of oil facilities in that area is linked closely to the possible development at Machiasport (Area 5). It is not likely that both will occur, or should occur.

The southern portion of Area 6, particularly southern New Hampshire is becoming a "bedroom" area for many people who commute and work in Boston. This is influencing the demand for coastal residential land in that part of the area and is likely to increase and expand northward as the Boston urban population grows.

The coastal waters of Area 6 are intensively used for waste disposal. Domestic waste disposal facilities vary from direct discharge of untreated sewage to collection and secondary treatment prior to discharge.

There is also a substantial use for both intended and inadvertant disposal of industrial wastes. This is especially true in and around the Portland and Portsmouth port facilities and includes the disposal of wastes from ships as well as land based facilities.

The disposal of waste heat into the coastal waters is a relatively small use at this time, but is expected to grow significantly in the future. (See Appendix P--Power.)

Another use of the coastal zone which was not of importance in Area 5, but which has been more significant in Area 6 is the disposal of dredging spoil and other solid wastes into the wetlands of the area (114). While the acreage of wetlands lost in this area is not great, it is significant in terms of the total wetlands in the area. However, both Maine and New Hampshire have recently enacted and are enforcing restrictive laws preventing marshland destruction. Consequently, the use of wetlands for waste disposal is now diminishing and is expected to be a minor use in the future.

Major Coastal Problems. Beach erosion is a significant problem in parts of Area 6. The littoral drift in the area is from north to south except where rocky outcrops form pocket beaches. Since natural nourishment is inadequate, a general loss occurs and many of the beaches, while of great length, are narrow. To maintain and improve these beaches to help meet the demand for beach recreation, a significant effort will be required in beach widening, raising and maintenance.

In the Maine portion of Area 6, coastal erosion is critical along about 20 miles of the coast. This occurs in the few heavily used recreational beaches. The small amount of material available through natural littoral transport is not sufficient to maintain these beaches. A Federal study to determine what can be done is underway, it indicates favorable projects are possible for several beaches.

Coastal erosion on the New Hampshire shoreline has been minor since the project which stabilized Hampton Harbor in 1935. However, there is a continuing net loss of material from the beaches, and renourishment is advisable to maintain the beaches for meeting the recreation demand. Several small projects for groins and beach nourishment have been authorized and some work has been accomplished both by Federal and State means.

While bacterial pollution of coastal waters is generally significant, it is a major problem in some parts of Area 6. For example, in New Hampshire the Great Bay Estuary has been closed to commercial clam productions since 1938 (131). There are over 2800 acres of potential clam flats in that estuary system. The economic implications of this lost resource are significant, estimated conservatively to be about $2 million per year at 1944 prices.

In Maine there are also substantial acreages of coastal wetlands closed to shellfishing because of pollution. It is estimated that 70,000 acres of the Maine coast have been closed for this reason with an attributable economic loss in 1967 of $1.8 million (167).

There are also cases where certain "desirable" species of finfish have disappeared from a particular area. However, a direct causal link to pollution has not been established in most of these cases, and other conditions, such as dams which block passage of anadromous fish, may have been the key factors.

While there are some instances of other activities being affected by coastal pollution, they are very limited in this area. However, the potential for important pollution effects will grow as the industrial complex expands, particularly around Portland. The development of additional petroleum handling facilities may well increase the chance of significant oil spills which can affect many activities. Shellfish in areas where oil exists have tended to pick up the oil flavor and odor making them unfit for human consumption.

A third problem of major potential impact is the preservation of the coastal wetlands of southern New Hampshire. The Hampton Marshes are a part of the largest remaining area of high quality coastal salt marsh in New England. As such, they warrant efforts to maintain them. Current legislation regulating their use and alteration is in force, and should be adequate to this task if enforced.

Major Prospects and Potentials. Area 6 is in the "transition" zone between the generally undeveloped and low income region of Eastern Maine and the intensively developed and high employment region which exists to the south (Area 9 and others). In this position it enjoys some unique advantages, both from an economic as well as an environmental quality standpoint. Certainly, there is need for continued growth economically. But this growth does not require a substantial amount of "leverage" except in special cases. (Portsmouth and vicinity may have a serious economic/employment problem as the Naval Shipyard at Kittery, Maine is projected to be phased out over the next few years.)

Based upon the trends and projections for population growth, the best use of much of this coastal area will continue to be recreation. Development of other uses should be controlled to minimize the detrimental environmental effects and to foster the growth of facilities which will contribute to recreational use.

Major coastal industrial development should be limited primarily to the Portland and Portsmouth areas which have adequate harbors and facilities for water transport. Other industry should be kept back from the shoreline.

Power production is expected to increase significantly in the next fifty years. This will require large amounts of water for cooling. Where possible, the heated effluents should be turned to beneficial uses to minimize potential ecological effects. Here again, the physical plants themselves should be so located (possibly back from the coast) that they have minimum effect on the recreational use of the shoreline while making use of the coastal water resource.

The coastal zone of Area 6 has very few characteristics which make it unique in the overall North Atlantic Region. It is important to the Boston population and others to the south as a vacation and recreation area and as a "nice place to live" for many commuters to Boston (particularly the New Hampshire portion).

From a regional coastal resource standpoint the national efficiency objective of NAR coupled with a significatn influence to maintain environmental quality seems most appropriate.

AREAS 7 and 9 (MASSACHUSETTS)

Area Characteristics. This sector consists of the coastal zones of Area 7 and of that part of Area 9 which lies in Massachusetts. The remainder of Area 9 lies in Rhode Island and will be discussed in the next section.

The approximately 1200 miles of Massachusetts shoreline is characterized by great diversity. The "mainland" -- that part of the state exclusive of Cape Cod -- has a very irregular coastline with many indentations. From the Rhode Island line to Buzzards Bay the coast is a mixture of barrier beaches, deep indentations, low rocky headlands, marshes and ponds. North of Cape Cod, cliffs and bluffs become apparent with intermingling sections of dunes. Beyond the 47-square mile expanse of Boston Harbor with its numerous islands, the shoreline becomes rockier until, beyond the Cape Ann peninsula, barrier beaches fronting vast tidal marshes are again found.

Separated from the "mainland" by the Cape Cod canal, the shoreline of the Cape Cod peninsula consists almost entirely of sandy beach varying from relatively narrow barrier beaches along the southern portion to extensive dune formations along the outer sections of the lower Cape. Several islands are found off the southern coast of Cape Cod, the most famous of these being Nantucket and Martha's Vineyard.

Numerous rivers empty into the Massachusetts coastal waters. In the northern portion, the principle one is the Merrimack, draining a large segment of Massachusetts and New Hampshire. Several important rivers drain into Boston harbor including the Mystic, the Charles, and the Neponset. The rivers draining into Buzzards Bay through the southeastern portion of the state include the Agawam and Mattapoisett.

Cape Cod, Nantucket, and Martha's Vineyard are sparsely settled regions having, according to the 1960 census, population densities of 179, 77, and 56 people per square mile, respectively (139). Economically, these regions are almost completely dependent on tourism and its supportive activities, e.g. the construction industry. Some commercial fishing is also done on Cape Cod, but it is not a major contributor to the economy. The population of all of these areas increases dramatically during the summer months, and the year round population of Cape Cod has steadily climbed in recent years.

The southeastern portion of the state, between the Rhode Island border and Cape Cod is an area of more dense population and considerable industrial activity. The major population center directly on the coast is New Bedford. At the present time this area is economically depressed. A second population concentration is found slightly inland at Fall River.

North of Cape Cod the population and economics of the region are dominated by the presence of Boston, the northern end of the Boston-

Washington megalopolis. Many of the coastal communities to the north and south of this area serve in part as "bedroom towns" for the city. There is much industrial activity especially along the north shore.

Ownership of the Massachusetts coastline is divided into 935 miles private, 175 miles public, and 90 miles Federal. In terms of shoreline use, some 800 miles are private recreational, 235 miles public recreational, 85 miles non-recreational, and 80 miles undeveloped. (136)

The islands south of Cape Cod are largely undeveloped. This is particularly true of the Elizabeth Islands chain which forms the eastern boundary of Buzzards Bay; only the outermost island is extensively used for permanent and seasonal residence. The same general pattern of undeveloped land in private ownership holds true for Nantucket and Martha's Vineyard. Here, however, there are some heavily used public areas including a state forest on each of the islands.

The primary land use on the Cape Cod peninsula is recreational, both public and private. The two main public facilities are the Roland C. Nickerson State Forest and the 27,000 acre Cape Cod National Seashore. Associated with this open space land use pattern are commercial developments and, in the southeastern portion of the Cape, some cranberry farms. A significant portion of land is Federally owned including Otis Air Force Base and sections adjacent to the Cape Cod Canal. A recent development along the canal is a 542.5 megawatt steam electric generating plant.

As one moves north from the canal along the "mainland" of the state, the areas adjacent to the shoreline exhibit a mixed pattern of recreational open space and residential land use with some commercial and industrial areas interspersed. Noteworthy is the new industrial area occasioned by the construction of a 650 megawatt nuclear power plant on Plymouth Bay. Commercial and industrial uses gradually increase until they peak at Boston. North of Boston, the pattern again becomes mixed until, beyond Cape Ann, undeveloped open space again predominates.

Major Coastal Uses. The physical diversity of the Massachusetts coastal area goes hand in hand with the wide variety of its uses. Marine transportation, waste disposal, conservation, recreation, and resource extraction are considered below.

The center of transportation in this area is Boston with the second largest tonnage in New England, handling some 22.6 million tons of cargo and almost a quarter of a million passengers in 1968 (138). Approximately one third of this traffic is imports, primarily residual fuel oil. This activity has remained at a relatively constant level over the past ten years and is not expected to change much in the future. In part the failure to expand is the result of the high labor costs in the area.

Minor port facilities are located at Fall River, New Bedford, and Salem. These harbors also handle primarily petroleum products. New Bedford is the base for a passenger ferry service connecting with Cuttyhunk, the end of the Elizabeth Islands chain. Other connections with the offshore islands of Nantucket and Martha's Vineyard are made through the Cape Cod ports at Falmouth and Hyannis.

Pollution is particularly apparent in the Merrimack Estuary and Boston Harbor. The Merrimack receives most of its pollutants from the Lawrence-Haverill industrial area. Boston Harbor receives the municipal and industrial wastes of the largest urban concentration in New England. In some coastal areas used for solid wastes dumps, the leachate has been a problem. Effort is being made to curtail the dumping of wastes such as sewage sludge, beryllium, magnesium, aluminum, sulfuric acid and other chemicals off the harbor. Sewage sludge in particular is considered to be a significant source of contamination.

Waste disposal has been one of the activities contributing to the loss of Massachusetts coastal wetlands. Between 1954 and 1968 the state lost about 1,200 of its 45,895 acres of wetlands, a loss of 2.6% in a decade and a half. Massachusetts has been a leader in wetland preservation. Its model legislation passed in 1965 and toughened recently (e.g., The Conservation Restriction Act of 1970) provided for the acquisition of wetlands and the restriction of activities in privately owned areas. Under this legislation some 12,000 acres have thus far been protected. In addition, the establishment of the Cape Cod National Sea Shore has served to preserve thousands of acres of valuable dunes and marshes on the lower portion of Cape Cod. The conservation drive of this area is also reflected in the current restrictions on exploitive activities in the Cape Cod Ocean Sanctuary and in the pending legislation to afford similar protection to Cape Cod Bay and the offshore islands south of Cape Cod.

Recreation is by far the largest scale use of the state's coastal areas. On Cape Cod and the offshore islands, the local economies are based almost entirely on it. About 90% of the state's shorefront is used for either private or public recreation (136). The "mainland" has several extensive public beaches. Boating is popular. Nearly 100,000 motor launches were registered throughout the state in 1969 (159) and coastal marinas are common. Along with boating, sports fishing is also popular. There are about 400,000 anglers in the state and about 3.5 million sports fish were caught in these waters in a recent year (44).

Between 1927 and 1943 Boston led the United States in the value of its commercial fish landings. In 1969 the state's commercial catch was 280 million pounds valued at $41.9 million (157). This was a sharp drop -- down 31% in volume and 9% in value just since 1966. In part this decrease is attributed to the continuing decline in the haddock and flounder landings which, along with lobsters, are the principle species caught. Commercial shellfishing is also an important activity in certain areas. Preliminary statistics indicate approximately 275,000 bushels were harvested in 1968, primarily quahogs and bay scallops (65).

Seawater is used for industrial cooling and processsing in many coastal areas just north of Boston and in the New Bedford area. This utilization will increase significantly when the power plant on Plymouth Bay goes into operation. Ground water is depended upon for a major part of the fresh water supply in the Cape Cod area. It has been noted that some well fields are pumping water with abnormally high salt concentrations during heavy use months.

Major Coastal Problems. As indicated earlier, commercial fishing has declined sharply in recent years. Particulary hard hit have been the haddock market in Boston and the flounder industry in New Bedford. Some shellfish areas have been closed to harvesting because of pollution.

Only Maine, New Hampshire and Rhode Island, of all the North Atlantic Region states, have lost less wetlands then Massachusetts. Wetland conservation in this state is considered a problem, however, because the residents appear to attach an unusually high importance to the preservation of their wetlands. The state is widely acknowledged as a national leader in wetland conservation.

Sand and gravel are in short supply in the Boston area. Traditional sources have largely been closed for environmental reasons by surrounding communities. Great difficulty has been experienced in obtaining granular fill for the extension of Boston's Logan Airport. As demand increases, it appears likely that sand and gravel will be increasingly extracted from ecologically acceptable offshore sources.

As already mentioned, coastal pollution peaks in the Merrimack Estuary and innermost parts of Boston Harbor. The problem here is typical -- tremendous costs versus environmental impacts. A review of pollution abatement activities on the Merrimack was cited in the earlier analysis of the selected problem of water pollution. The river has been considered as a possible additional source of water supply for Boston.

The coastal waters are likely to be used increasingly to discharge waste heat from power plants required to satisfy mushrooming demand. Possible problems and opportunities were discussed at length in the earlier analysis of the selected problem of thermal effects.

The supply of recreational facilities is becoming the most critical problem in the Massachusetts coastal zone. This recreational demand is particularly felt along the coast south of Boston where current facilities are already used to capacity. This demand stems from both local residents and out of state visitors. The establishment of the National Sea Shore has heightened this pressure and between 1963-1968 the number of visits increased from 1.8 to 3.5 million (100). As the population of this state and the areas to the south increase, more and more pressure will be exerted on these coastal areas.

Erosion has been evaluated as significant in this area because it only seriously affects about 135 miles of the 1200 miles of shoreline. Almost all occurs in the islands off the southern coast and the ocean side of the north-south arm of Cape Cod. Local severe erosion occurs along the south shore of the Merrimack Estuary, Boston's outer islands, and the Marshfield-Scituate cliffs areas (136).

Tidal flooding occurs particularly in the Buzzards Bay area. A recurrence of the tidal flood of record there has been estimated to cause damages of about $60 million. Without the existing hurricane barrier in this reach, the estimated damages from this same storm would be about $100 million.

Major Prospects and Potentials. The use of this coastal zone for recreation is seen as one of its major potentials. The increasing demand referred to above combined with the physical appeal of such areas as Cape Cod and the offshore islands result in an unusual opportunity for this area to serve as an outlet for millions of recreation seekers, and the danger that overexploitation of natural resources will destroy the very desirability of the area. Some measure of access control will need to be developed to protect against possible overutilization.

Boston Harbor is also seen as having a major potential for supplying a recreational outlet. This large expanse of water with its myriad islands presents an uncaptured opportunity for the enjoyment of many. This conclusion was reached in the report of the Second Commission on the Boston Harbor Islands (66). However, the fulfillment of the goals recommended by this commission will require a renewed emphasis on pollution abatement.

A second potential for this area can be found in a revitalization of its formerly extensive fishing industry. The fertile areas off the northeastern coast are currently being fished primarily by non-American fleets. The proximity of this area combined with the large domestic market, currently satisfied to a large measure by imports, offers significant opportunity for this area. This is particularly true of the New Bedford area which is now economically depressed. However, such a revitalization would require basic changes in the present industry and the Federal view of this activity. A more extensive discussion of this topic can be found in the preview analysis of the selected problem of living resources.

AREA 9 (RHODE ISLAND)

Area Characteristics. Rhode Island has approximately 340 miles of shoreline. It is dominated by Narragansett Bay, a drowned river embayment, covering some 170 square miles and accounting for 150 miles of total shoreline. The bay is relatively deep and contains several islands. The main rivers draining into it are the Seekonk and the Taunton. The Pawcatuck flows into Block Island Sound. The entire coastal area contains many fresh-water ponds and lakes as well as salt-water ponds behind barrier beaches along the sourthern coastal area.

The topography of the coastal land is low and flat. A 1965 report (106) estimated that about 88% of the shoreline was more or less in a "natural" state and that approximately 4,200 acres of salt marsh and meadow were available along the shoreline.

The coastal area surrounding Narragansett Bay is an area of high population concentration with a peak density at the head of the bay in the communities around Providence. Another population cluster exists around the port of Newport. In contrast, the coastal areas along Block Island Sound are more sparsely settled with Washington County having a population of 178 per square mile according to the 1960 census (139). Projections show that the population will increase by some 37% by the year 2000 (106), but that it will be more evenly dispersed as the highway system improves. The influx of summer residents to the coastal area is moderately high on the mainland and very high on Block Island. No data is available to indicate what percentage of these are from out-of-state and what percentage are relocations from other parts of Rhode Island.

The coastal population receives a per capita income comparable to the national average and is expected to maintain this ratio through the year 2020. Although the United States Navy is the largest single employer in the Rhode Island coastal zone, manufacturing is the chief source of basic income to the area. Other significant economic activities relate to ship-building, recreational boating, and tourism. Commercial fishing is still a significant source of income to certain areas, although its pattern of activity is changing.

A view of a current land use map of the coastal zone of Rhode Island shows a prevalence of residential areas. Along the sourthern coastal portions of the state, a great deal of space is also occupied by usage classified as "recreation and conservation". This includes the Burlington State Park, the Ninigret Conservation Area, and some 28 miles of sand beach, both public and private. Little industrial land use is found in this area, and the extent of commercial land use is moderate and generally interspersed among the residential areas. Some Federal military use is also found, i.e., Charlestown Auxiliary Naval Air Station, but a high percentage of the land is still classified as "vacant".

As one moves up into Narragansett Bay the percentage of "vacant" land rapidly dwindles and land use patterns become more mixed. Federal military land use is high in the sourthern portion of the bay. The Navy controls 31 miles or nearly 8 percent (106) of the total shoreline. The Navy also controls extensive portions of the southern half of the bay waters. Commercial and industrial uses also increase as one moves north into the bay until, in the Providence area, they match residential use. Recreational uses are also signi-ficiant in this highly urban area. These include several parks (Goddard Memorial, Colt, and Haines Memorial), as well as several fishing areas and beaches, both public and private.

Block Island has a large portion of vacant land. The rest of its land use can be classified as residential with some commercial land use devoted to the seasonal tourist industry.

Major Coastal Uses. The above pattern of physical, population, and land use characteristics is reflected in the major coastal uses of this area -- marine transportation, waste disposal, commercial fishing, and water-oriented recreation.

The waters of the Rhode Island coastal area are used for transportation by five major groups: commercial cargo carriers, naval vessels, commuter carriers, commercial fishing vessels, and recreational boats. The extent of this activity can be perceived from the following facts.

- The port of Providence is the fourth largest in New England and as such serves as a major distribution center for commodities coming into the area. It handles some 9 million tons of cargo annually (138).

- The Navy uses its Narragansett Bay facilities as home port for approximately 70 ocean going vessels as well as many smaller craft.

- In addition to the Naval ports and the major port of Providence, there are five state piers and several smaller ports in the area, including Point Judith and Galilee.

- There were 14,800 pleasure motor boats registered in the state in 1969 (159). Although all of these boats may not have been used in the coastal zone, the statistic serves to give some idea of the volume of this activity. In addition, consideration must be given to the number of boats not required to register and the number using these waters from out-of-state.

The full impact of this large amount of water traffic must be seen in light of the many secondary activities associated with it. These activities include port cargo handling, marina development, and channel dredging, to name but three. When viewed thus, it can be seen that the volume and economic impact of transportation in this area is indeed considerable.

As with most coastal waters, those of this region are used extensively for waste disposal. Fortunately, in Narragansett Bay, the tidal action enables the water body to assimilate a substantial portion of this waste thus somewhat mitigating its polluting effects. In the earlier analysis of the selected problem of water pollution, Narragansett Bay was selected to illustrate the classic distribution of wastes (Figure U-6) in a major estuary -- poor water quality in the poorly-flushed finger-like subestuaries especially below urban centers and excellent quality in the open waters of the estuary proper.

Narragansett Bay receives the sewage wastes of about 90% of the population of Rhode Island, some 150 million gallons per day (107). Twenty percent of these wastes receive primary treatment, 70% receive secondary treatment, and 1% receive tertiary treatment. The remainder of the wastes are not treated at all. Along the southern coast, some areas do not have central treatment facilities. In this case the burden on the coastal waters is also increased by leakage from septic tanks of many of the shore residences. In addition, no regulations now exist concerning waste disposal from boats. Consequently, the large volume of water traffic discussed above also dumps its untreated wastes into the coastal waters.

Commercial fishing is pursued throughout the coastal waters of this region. The once large shellfishing industry has been sharply curtailed in recent years. In part this is due to the mysterious disappearance of the oyster. Another factor has been the restriction placed upon the industry due to the polluted waters at the head of the bay. However, as this segment of the industry has declined, the finfish catch has increased both in volume and value. Thus the total catch in 1965, landed primarily at Point Judith, amounted to 48.7 million pounds, valued at $4.6 million.

The forms of water-oriented recreation pursued in this region include swimming, surfing, scuba-diving, boating, and fishing. The beaches are found predominantly on the sourthern coast, on the coast just north of Point Judith, and on Block Island. Only a relatively small portion of the shoreline classed as beach (185 miles, Table U-15) is now being used for water-oriented recreation. Where beaches are available for public use, attendance is high. For example, the beaches in Narragansett Bay recorded over 1.7 million user-days in 1967 (107).

The statistics cited under water transportation give some idea of the magnitude of the recreational boating activity in this area. The coastal area, as of 1969, contained some 26 yacht clubs, 25 yacht basins and harbors, 35 boatyards, and eight charter boat enterprises (107). In addition to the resident boaters, yachtsmen from other states are attracted to this area. It has been estimated that nearly 40% of the boating time in these waters is devoted to sport fishing.

Major Coastal Problems. Water pollution and coastal erosion and tidal flooding are major problems in the Rhode Island coastal zone. The pollution of the coastal waters is perceived locally to be the single most important problem. The largest source of these pollutants are municipal and industrial wastes, with sewage from boats also being a contributor. The subterranean waters of the area are also suffering from pollution by industrial wastes.

Economically, the pollution in this area has had a severe impact on the shellfishing industry in Narragansett Bay. Even where the resource is still available, the costs of harvesting it are increased by the need to depurate it by treatment or transplant. In addition, the existence of polluted waters has impacted on the extent and desirability of recreational pursuits in the area. Although much effort and money has been expended in the establishment of waste treatment facilities, the problem is expected to become more severe as growth outpaces facilities and other demands upon the use of the waters increase. Pollution of underground acquifers may become a significant problem as the need for additional water supplies is reached.

The "Report of the Governor's Committee on the Coastal Zone", March 1970 (107), suggested a four pronged attack on this problem including encouragement of voluntary pre-treatment by firms and sharing of treatment facilities with these firms by the municipalities, increased attention to the siting of industrial establishments with a view toward surrounding water quality, examination and setting of water quality standards in areas with consideration for activities occurring in the area, and the procurement of additional funds for the upgrading of sewage treatment facilities and staffs. Pursuit of these four activities combined with stringent enforcement of adopted standards will be necessary to deal significantly with this problem.

The most critical erosion areas are located west of Narragansett Bay, along Cliff Walk in Newport and on Block Island (136). Tidal flooding is a serious problem in Narragansett Bay. The hurricane of 1938 killed about 250 people in Providence and caused property damage estimated at about $125 million. A recurrence of this storm would cause an estimated $150 million in damages under current conditions and about $200 million without the existing hurricane barrier at Fox Point. This barrier which was completed in 1966 cost $17 million and the proposed Lower Narragansett Bay Barrier has an estimated 1970 cost of about $133 million (31).

A significant difficulty in this area, in terms of recreation, is public access to the shoreline. Access is limited by the extensive amount of land in private ownership as well as restrictions on parking in areas surrounding municipal beaches. Limited state ownership of shoreline areas further restricts public access; the state owns only about 7 miles of the 340 mile shoreline. In addition there is a lack of facilities for such activities as boat launching.

In March, 1970, a major study by the state entitled Public-Right-of-Way to the Shore (108) was published. The recommendations resulting from this study included the further acquiring and developing of rights-of-way by the state, the obvious marking of those areas to make them known, and the legal delineation of shoreline property rights.

The conservation of the state's wetlands is a significant concern of the people in Rhode Island. The state has less coastal wetlands than any state in the NAR, only a third as much as New Hampshire and a seventh as much as Connecticut, the other two states with little wetlands. Over the last decade and a half wetland losses have been kept to an average of 10 acres a year. How this loss compares with the normal expansion and contraction of wetlands through natural cycles of climate, erosion and deposition has not been determined.

Several conservation areas are scattered throughout the coastal zone. They include management areas, bird sanctuaries, and wildlife preserves, both publicly and privately owned. The State of Rhode Island is actively engaged in a plan of acquiring coastal areas by purchase for the purpose of preservation, although some of these areas may be used for passive-recreation. In addition, regulations concerning the spoiling and destruction of wetlands are being rigorously enforced.

Major Prospects and Potentials. Narragansett Bay provides an almost ideal, close in, scenic, protected water body for recreational boating. There are about seven acres of Bay for every one of the state's 15,000 registered boats. Although all boats would never be on the Bay at once, the allocation of some parts of the Bay for Navy use, the tendancy of boaters to cluster in preferred locations, and rapidly increasing participation by the public all point up the possibility of traffic congestion during peak periods in the future.

A proposed solution to this "problem" is "water area zoning". This is done now in areas of the Bay restricted for the sole use of the Navy. Unless and until congestion became a real problem, however, it is unlikely that there would be much support from recreational boaters to restrictions on their traditional freedom of the seas. Much more likely, for safety purposes, would be a system of licensing and enforcement to provide some control on boat operators and to emphasize basic knowledge concerning boat operations.

Many different groups -- conservation, recreation, residential, industrial and commercial -- see potentials for the state's coastal areas in different lights. To provide a means for the judicious allocation of space to these various interests, the state considered legislation in 1970 to establish a Coastal Zone Council. The Council would develop and implement a coastal zone plan for the "preservation, protection and development" of the state's coastal zone. The legislation was defeated, but is is expected to be submitted in a form which will increase its recognition of the viewpoint of coastal communities in addition to the state as a whole.

AREAS 8 and 10

Area Characteristics. Areas 8 and 10 contain the Connecticut coastline. It is very irregular with many bays, coves, and promontories. Several small offshore islands dot its central and western portions. Of the approximately 270 miles of shoreline, some 145 miles are beaches, located primarily east of Norwalk harbor. Many of these are narrow, normal tides approaching the backshore making them inadequate as protective features or as recreational areas without some modification. West of Norwalk Harbor, the coastline is rockier.

Three main rivers drain this area. Proceeding from east to west, these are the Thames, the Connecticut, and the Housatonic. In addition, many smaller rivers also drain into Long Island Sound. The principal of these is the Quinnipiac which, at its mouth, forms part of New Haven Harbor.

In comparison with other areas of the state, the western portions of the coastline are densely populated. Here are found the major population centers of Stamford, Norwalk, Bridgeport, and New Haven. This area is quite industrialized and the smaller communities serve as "bedroom towns" for the metropolitan New York City area. The area has a high per capita income with almost 30% of the population earning over $10,000 per year according to the 1960 census (140).

Despite this population concentration, a large proportion of the land is still considered "open space". There areas, however, are predominantly in private ownership as part of large residential tracts. Only two state parks are located in this area, Sherwood Island State Park and Silver Sands State Park, and little of the available beach area is open to the public. Commercial and industrial land use predominates in Norwalk, Bridgeport, and New Haven.

At New Haven, the megalopolis concentration turns north, and the coastal area becomes less heavily populated. Although it possesses some industry, the area between the Quinnipiac and Thames Rivers is primarily oriented toward the recreation and tourist industries. This emphasis is reflected in the increased population concentration during the summer months, a large proportion of which migrates from other areas of the state. In contrast, the area surrounding the Thames estuary has 75% of its employment in the defense industry. This coastal region also maintains an income higher than the national average, as does the state as a whole.

From New Haven east, almost all the land is classified as residential and open space. An exception is the New London area where a significant portion of the land is federal owned or zoned for industrial use. Three state parks are located in this portion of the coast - Hammonasset, Rocky Neck, and Harkness Memorial.

However, as in the western portions, a large proportion of the land is in private ownership. Indeed, statistics for the state as a whole show that of the 270 miles of shoreline, 215 are in private ownership, 50 in public ownership, and 5 miles in Federal hands (136).

Major Coastal Uses. The same source cited above (136) gives a breakdown of shoreline use which shows that 78% of the shoreline is pre-empted by residential and private recreational use. This leaves only 30 miles of shoreline for public recreational use and the same amount for commercial and industrial use. This distribution is reflected in the relative magnitude of the various activities carried on in this area. Some of these, including recreation, transportation and waste disposal, are briefly discussed below.

As noted above, marine oriented recreation is extensive in this area. Two primary types of recreational activity are finfishing and boating. Exact statistics on the extent of these activities are difficult to obtain; however, it has been estimated that more than 1.5 million man-days of saltwater fishing were enjoyed in this area in 1965 (152). The magnitude of the recreational boating activity can be perceived from the 1970 Connecticut Marina and Yacht Club Directory (29) which lists more than 130 marinas along the coast having over 12,000 slips and moorings, and some 70 yacht clubs. In addition, the Coast Guard Boating Statistics for 1969 (159) reports almost 50,000 power boats registered in the state.

Outside of recreational boating, other transportation activities are found in this area. New Haven harbor, at the mouth of the Quinnipiac River, ranks as the third largest port in New England in terms of short tons handled. This volume was 11,297,138 tons in 1968 (138), a slight reduction from 1967 but a significant increase over the preceding year. The principal commodities received were petroleum products, as well as large amounts of scrap metal and coal.

Other substantial cargo handling facilities on the Connecticut coast, in order of magnitude, are located at Bridgeport, New London, Norwalk, and Stamford. The bulk of the material handled in Norwalk is coal, but the other ports handle primarily petroleum products. In all cases the major cargo handled consists of coastwise receipts. In addition, ferry passenger services at Bridgeport and New London connect with Long Island and off-shore islands primarily during the summer.

As in most other coastal areas, the wetlands and waters of this region have been the sites of many waste disposal activities. The use of wetlands as dumps was cited as the most important of the specific causes listed for the destruction of these areas in the years 1954-1964 (154). In this period some 294 acres were thus destroyed, primarily in the New Haven area.

The uses of the waters for liquid waste disposal is especially apparent in the heavily populated sections of the coast west of New Haven. This burden stems not only from coastal sources, but also from the waters draining upland areas. This is particularly apparent in the Bridgeport area where several streams draining into the area are of "D" quality. West of New Haven most areas do not have central sewerage facilities, and leachates from septic tanks cause some problems in coastal waters.

Although at one time a sizeable industry, the current commercial extraction of the living resources of the Connecticut coastal zone is a minor activity. In 1968 the entire industry employed only about 400 people, and the total dollar value of the catch in 1969 was only $1.8 million (117). More than half of this catch is accounted for by lobsters. The other landings include hard clams, oysters, and a variety of finfish landed primarily at Stonington. Included in the latter category are large amounts of flounder, scup, and whiting. Not reflected in this itemization of landings is the extent of the seed oyster market, located in the western portion of the coast around Fairfield and Bridgeport. This segment of the industry has also declined in recent years and its current value is not available.

Major Coastal Problems. As was seen in Table U-18, the major coastal problem confronting this region is recreation -- how to satisfy the demand. Currently, most of the Connecticut coastline is either in private ownership or restricted public use as town beaches. The need is for more state park facilities for recreational pursuits and more shorefront access points to help satisfy the increasing demand for fishing and boating areas. A solution to this problem must be found in increased purchase by the state to open these areas up to wider utilization. Improved water quality and beach replenishment activities would also upgrade the quality of the recreational experience in this area.

A second problem of the coastal region is the preservation of a rapidly dwindling supply of coastal wetlands. It has been estimated that 21% of these areas were lost in the fifteen year period between 1954 and 1968 (114). Although efforts are currently underway to protect these areas, higher prioirty needs to be assigned these activities to combat the rapidly increasing pressure for housing developments in these areas.

Scattered along the Connecticut coast are approximately 25 miles of shoreline which are subject to critical erosion. Although this area is protected from the full effect of Atlantic storms by the prescence of Long Island, the shore lacks natural resiliency. The beaches are very narrow and offer little protection to the backshore which consists of erodible unconsolidated materials. The sand moves offshore to form bars and spits, and little is returned naturally to the beach between storms because of the lack of beach building swells (136).

Tidal flooding is a significant problem along the Connecticut coast although probably not as bad as in adjacent Rhode Island and New York. A recurrence of the tidal flood of record would produce damages of about $66 million. Hurricane protective structures have been provided at Pawcatuck, Stamford, Mystic and Westport. They would prevent an additional $12 million in damages and a funded project at New London would prevent an additional $4 million in damages. A variety of structural and non-structural devices to mitigate these damages have been studied by the U. S. Army Corps of Engineers.

Although not currently a difficulty, thermal effects are likely to become a major concern for this area in the near future. Several power plants now exist in this coastal area, primarily west of the Connecticut River, and indications are that others will be similarly situated to take advantage of a bountiful supply of cooling water as the demands for electrical power increase.

Major Prospects and Potentials. Besides being the major problem in the Connecticut coastal zone, recreation also offers the biggest potential for this area.

The key point with regard to Long Island Sound is that although it does not offer the spectacular recreational pursuits of areas like lower Cape Cod, it is in close proximity to a large population and can thus provide a satisfactory recreational experience to many. It is this perhaps lower quality but much more available recreation potential which must be emphasized.

The protected waters of the Sound offer the potential for a wider range of boating activities than are found in other more exposed coastal areas. The extensive marinas already existent along this area bear witness to this fact. However, an increase in publicly owned launching sites would allow for greater utilization by smaller craft. This would particularly impact upon the "day fishing trip" uses of these waters.

Another potential for both recreational and commercial interests lies in the revitalization of the shellfish stocks all along the coast, but particularly in the western areas. These species have in the past been severely reduced by pollution and the destruction of nutrient areas. Even where stocks now exist, health requirements prevent their harvesting. Some study should be directed toward the feasibility of constructing a depuration plant to increase immediate yields.

Two other potential developments in this area need to be mentioned. The first deals with the proposed bridge from Long Island to Connecticut, a bypass to the New York City area. Although likely to be of great benefit to Long Island, no positive values are likely to accrue to this coastal area from such a structure. In fact, removal of shoreline areas, the increased traffic, and the impact upon the ecology of near shore waters will only serve to further deteriorate an already stressed area.

The second potential development concerns proposals for the placement of an off-shore airport facility in Long Island Sound. The shoal area that has often been mentioned for this undertaking lies off the mouth of the Connecticut River. Careful review will be necessary to determine whether the deletorious affects which are likely to accrue to other activities in the area, such as recreation, are worth such an undertaking.

SUBREGION C

This subregion consists of the coastal zone of New York State. For treatment it has been divided into two sectors. The first is Westchester, Nassau and Suffolk Counties, the last two comprising most of the land area of Long Island. The second sector consists of New York City with its boroughs of Queens and Kings on Long Island, Richmond on Staten Island, Manhattan on Manhattan Island and the Bronx on the mainland.

Each of these two coastal sectors is considered herein in terms of its area characteristics, major coastal uses, major coastal problems, and major prospects and potentials.

Table U-19 summarizes some broad judgments as to the relative importance of the selected problems in this subregion.

TABLE U-19

PROBLEM PROFILE IN SUBREGION C

Problem ✱ Highly significant * Significant ● Relatively insignificant	Living resources	Conservation of wetlands	Non-living resources	Water pollution	Thermal effects	Solid wastes disposal	Recreation	Marine transportation	Coastal erosion and tidal flooding
Area 13 (Nassau Suffolk & Westchester Counties)	*	✱	✱	✱	✱	●	✱	*	✱
Area 12 & 13 (New York City and Hudson River)	●	●	●	✱	*	✱	✱	✱	✱

AREA 13 (NASSAU, SUFFOLK AND WESTCHESTER COUNTIES)

Area Characteristics. This section focuses principally on the coastal areas of Nassau-Suffolk counties on Long Island. The coast of Westchester County along Long Island Sound is also included from a coastal perspective; it has much in common with the Nassau County coast from which it is separated by a narrow 3-6 mile reach of Long Island Sound. Because of Long Island's much larger size and unified data base, most of the following comments will cite Long Island without constant adjustment for the Westchester coastal appendage. Comments on the North Shore in Nassau County can generally be assumed to apply substantially to this Westchester coastline except for local adaptations below the scope of this broad overview.

The Nassau-Suffolk area can be thought of as a 1,200-square mile, 20-mile wide peninsula extending 100 miles into the sea with an exposed Atlantic-oriented flank on the south and a semi-protected Sound-oriented flank on the North. The bi-county coastline is over 500 miles long. The island marks the southernmost limits of the Ice Age. Its 2000-foot thick deposit of granular soils, its vertical drainage, its 300-foot North Shore morains and its gentle slope southward all are products of the retreating glaciers.

Physically, the North Shore is closely related to nearby Connecticut by Long Island Sound, a common resource. The Westchester coast and the western half of the Long Island coast are very irregular, with numerous deep bays and promentories. Eastward the coast becomes very regular with very few indentations. Along the entire North Shore, beaches are generally narrow and rocky or pebbly. They usually front high bluffs or small marshes. Except at the heads of embayments, large wetlands are uncommon. Along the Sound, beaches make up 8 of the 42 miles of coast in Westchester County, 5 of 18 in Nassau County and 75 of 87 in Suffolk County.

The East Shore, with 168 miles of shoreline between Orient and Montauk Points, is almost all beaches. Many of them are gravelly and very narrow. They front low bluffs on the north fork and glacial headlands up to 240 feet high on the south fork. Wetlands are common, particularly along the westernmost part of this shoreline.

The 108-mile South Shore consists of long 1/4-1/2 mile wide, sandy barrier beaches facing a strong Atlantic surf. Behind these barrier beaches, for almost the entire South Shore, are long, shallow, guiet backbays. The most prominent of these are Great South Bay, Moriches Bay, Skinnecock Bay and Mecox Bay. Unlike the salinity in the backbays of Virginia and the South Atlantic coast, salinity here is somewhat lower than in the nearby ocean.

Although physically the North Shore of Long Island may be closely related to nearby New England, from a socio-economic viewpoint all of Long Island is oriented toward New York City to the west. Population densities decrease in almost direct proportion to distance from the City. The essentially residential character of the Island's development reflects its surburban relationship to the City. Except for a few summer-operated ferries and a low volume of air traffic, the Island is socially and economically isolated from New England. Almost all transporation points toward New York City. As implied earlier, the screening effect of time-distance from New York City is very evident. The farther out on the island one goes, the more open is the terrain and natural aesthetic features become more prominent. This pressure of population spreading outward from the City, combined with major recent improvements in transporation, have made Westchester, Nassau and Suffolk Counties among the fastest growing counties in the nation. For example, in 1940 the Nassau-Suffolk population was less than 5% of the 12 1/2 million living in the New York region. By 1985 these two counties are expected to have about 15% of a 22-million population (72). How to accommodate this rapidly expanding population, and still preserve or enhance the environmental emenities for residents and the increasing number of day visitors from the metropolis is perhaps the central problem for long range planning in the Nassau-Suffolk-Westchester Counties. Put more simply: Given that the area will primarily be a place to live, how can it be made and kept a very nice place to live? As will be seen, the area's coastal zone can play an important role in answering this question.

Major Coastal Uses. The commercial fish catch here has fluctuated widely over recent years, as it has in most coastal areas. The fluctuations are especially prominent on a species by species basis. In 1968 the dockside value of the commercial catch was $14.3 million (156). More than three-quarters of this total was represented by shellfish. Hard clams, almost all of which came from Great South Bay, accounted for about two-thirds of this value with the next most commercially significant species, sea scallops and Northern lobsters, trailing far behind. Among the finfish the most valuable species were the scup, yellowtail flounder, and fluke, but none of these species had a value even close to any of the three shellfish species mentioned.

The most important non-living resources, by far, are fresh water and sand. Like most islands with granular soils, Long Island has a very large lens of underground freshwater, with a defined freshwater-saltwater interface which advances and retreats with variations in precipitation and extraction. The aquifer is one of Long Island's most important natural resources. Currently, it supplies all of the fresh water in the bi-county area but in view of increased requirements estimated in the future some major problems, considered later can be foreseen.

To meet requirements in the market area, Long Island's production of sand and gravel has recently averaged about 14 million short tons annually (88). Most of this is sand, which is plentiful on Long

Island. Most of the gravel needs are met by imports. The problem on Long Island is to extract the sand in an environmentally acceptable way. Many towns no longer permit sand mining. The difficulty should be resolvable if the excavator is required to restore the site in a defined way, compatible with approved long-range land use plans, and post bond as assurance that he will do so. Important as the environmental impacts might be, however, this problem is not basically a coastal one. In this sand-surplus region, little sand and gravel is currently extracted offshore and the practice will probably not become competitive with land-based extraction in the future, except possibly for beach nourishment.

The disposal of the sector's water-borne and thermal wastes is greatly simplified by the assimilative capacity of the ocean and Sound. However, this assimilative capacity is far from infinite and some problems related to this fact are discussed later. Solid waste disposal is a problem as it is in all densely populated areas, but unlike the situation in the New York City area, its disposal in the bi-county area is not now, or expected to become, primarily a significant marine or coastal problem.

Probably the most significant use of the sector's coast is for human enjoyment in the form of outdoor recreation and aesthetic satisfaction. The long oceanfront beaches, especially, are ideal for most forms of beach and water-contact recreation. Where the oceanfront is made reasonably accessible and adequate facilities are provided, the public response has been great. For example, Jones Beach accommodated about 13 million visitors in 1969 (136).

The sector's coastal waters can satisfy a complete spectrum of boating needs. For the shallow-draft craft such as rowboats, motorboats, and small sailboats, the South Shore bays have a special appeal. The deeper-draft, hardier, marina-based craft such as cabin cruisers and most sailboats prefer the deeper, broader, but semi-protected waters of the Sound and East Coast. On calm days, the larger recreational craft from the North Shore and Connecticut visit each other's shorelines to fish and put ashore. Some problems requiring interstate coordination arise because of differences in the two states' regulations on fisheries and vessel-pollution control.

Sports fishing is closely related to boating and is most prominent along the East Coast. In addition to its recreational aspects, it has a commercial value probably greater than its commercial fishing counterpart.

All of the coasts provide seasonal aesthetic relief from the metropolitan areas where the people work and the residential areas where they live. On the South Shore, fresh salt air, cooling breezes, and glimpses of the ocean and nearby undisturbed expanses of wetlands provide a multi-dimensional appeal. The North Shore with its many high promentories emphasizes visual appeal, enhanced by its many coves and the flotilla of sails which speckle the waters during the summer. The East Coast, more than any of the others, has managed to tailor its development to conform aesthetically to its marine environment. Much of its quaint charm stems from its architecture and numerous boat landings which transmit the tang of the sea to the beholder.

In contrast to nearby New York and Connecticut, the Nassau-Suffolk-Westchester area has really no major ports. Of about 12 million short tons handled in this area in 1968, most was accommodated at Hempstead Harbor (5 million), Port Jefferson (2 million), and Port Chester-Westchester Creek (2 million)(138). The receipt of petroleum products and the shipment of sand accounted for almost all of the total. Essentially, all the tonnage is accommodated on the North Shore. Long Island Sound provides a protected waterway primarily for the movement of refined petroleum products from northern New Jersey to the southern New England ports. Car ferries at Port Jefferson and Orient Point move a low volume of traffic to Connecticut, and this is only during the summer months. Several ferries link Fire Island, Plum Island, and Shelter Island to Long Island. A few of them run all year around.

Defense establishments are of very minor importance to the sector's coastal zone.

Land use in the coastal zone is intimately related to all other uses. Especially in the southwestern corner of the bi-county area, the demand for residential lands has put increasing pressure on the easy-to-fill wetlands, but in recent years, this use has been increasingly arrested. For the Nassau-Suffolk area, as a whole, about 62% of the land and water surface may be considered broadly as open space and 38%, broadly, as developed. Within the open-space category are vacant (33%), water (14%), agricultural (8%), and recreational (7%). Within the developed category are residential (21% overall, 45% in Nassau County), roadways (8%), institutions (4%), transportation, utilities, and communication (3%), commercial (1%) (72). Current shoreline ownership patterns are reflected in Table U-20.

<u>Major Coastal Problems</u>. As indicated in Table U-19, of the nine major coastal problems selected for special analysis in this appendix, six can be considered as highly significant in this sector. These problems, listed in the same order as they were analyzed, are conservation of wetlands, water pollution, thermal effects, recreation, and coastal erosion and tidal flooding.

Conservation of wetlands was analyzed as a selected problem earlier. The advantages of preserving and preferably enhancing wetlands for their nutrient, habitat and aesthetic values was covered. During the period 1954-1964 Nassau and Suffolk Counties lost 8,200 acres of marshland, 24% of their 1953 total, to landfill. Most of the fill was for residential development and dredging spoil disposal (112). The pressure for increased filling is reflected in the market

TABLE U-20

SHORELINE OWNERSHIP PATTERN

Reach	Ownership Pattern -- in miles 1/ Federal	Non-Federal Public	Private	Total
Sound Shore of Westchester County		9	32	41
South Shore Oceanfront	14	36	58	108
South Shore embayments 2/	15	67	90	172
East Shore	4	40	124	168
North Shore of Suffolk County	—	16	71	87
North Shore of Nassau County	—	4	12	16
TOTAL - miles	33	172	387	592

1/ Shoreline length varies with the detail with which coastal configurations are measured. The lengths used here are taken from (136).

2/ Does not include embayments in the Town of Hempstead or east of Shineecock Bay.

value for filled coastal land, about $5,000 to $15,000 an acre. To counter these pressures increased governmental awareness at all levels from the community to the Federal government is required and is apparently emerging. As pointed out earlier in the special analysis of marine transporation, there are numerous alternative ways of disposing to dredging spoil without destroying wetlands. These alternatives include the improvement and creation of wetlands, if that is desired, or disposal at sea.

The water pollution problem here is intimately related to water supply and coastal water quality standards. Considerable relevant information is presented in Appendix D - Geology and Ground Water, in Appendix L - Water Quality and Pollution, and in references cited therein. A number of options or combination of options must be considered in developing the bi-county strategy for water supply and liquid waste disposal for the future. With respect to water supply, options include importing water through New York City, reuse of water, replenishing the aquifer, and possibly desalinization of sea water. With respect to waste water disposal, options include minimal treatment and disposal by ocean outfall; greatly improved treatment and disposal to surface streams; various degrees of treatment and injections into one of the aquifers; and land disposal methods which conceive of the waste materials as nutrients and the soil as a living filter that improves water quality by natural processes before the water leaches into the aquifer or is consumed by evapo-transpiration. Whatever strategy is adopted, it is clear that the interrelationship between water supply and waste water disposal must be thoroughly considered.

From a uniquely coastal point of view, the strategy must take into account the coastal water quality standards and salinity concentrations in the South Shore bays. These concentrations are influenced by underground seepage of fresh water. Unusual changes might affect marine life which is sensitive to salinity concentrations. However, the hard clam which is currently the most valuable species in the Great South Bay requires a rather high salinity (27.5 ppt for spawning) not far below that of seawater.

It is apparent that the disposal of wastewater on Long Island requires careful consideration of numerous factors, included in which are the maintenance of coastal water quality standards and marine life.

Thermal effects in coastal waters were analyzed earlier as a selected problem. An 820 megewatt neclear power plant, Long Island's first, is being considered at Shoreham, halfway out on the island on the North Shore. Although the assimilative capacity of Long Island Sound appears ample, considerable concern has been expressed especially regarding the local effects on marine life. Currently, an experiment is underway at Northport to evaluate the possibility of thermal discharges from the fossil fuel plant there, benefiting marine life in the vicinity. In light of the predicted many-fold increase of the use of the North Shore for this purpose, it is important that the possible environmental effects, harmful or beneficial, be examined carefully. Depending upon the results of these evaluations, a wide variety of alternatives exist as suggested in earlier special analyses. Whatever ameliorating alternatives are employed, however, it seems likely that thermal energy can better be dissipated along the North Shore than almost any place else in the general vicinity.

The recreation problem here is how best to accommodate the outdoor water-based recreational and aesthetic needs of a rapidly growing population. Problems in meeting this demand include the seasonal disuse of the resources (about three-quarters of the year), the inferior beach quality of most of the North Shore, East Shore and backbay coastline, the desire to provide both high and low density beach recreation, and some limitations of access.

Almost all of Long Island's Atlantic and Sound shorefront is classified as beach, but the quality of the South Shore beaches is much higher, at least as indicated by patronage. For the western two-thirds of the Island, the ocean beaches are publically owned. Access there is unlimited except for about 20 miles of Fire Island where access is difficult (only by no-car ferries), helping to preserve its low density appeal. As one moves farther eastward, oceanfront ownership becomes increasingly private. Along the North Shore most of the coast is privately owned. Sunken Meadow and Wildwood State Parks offer excellent facilities for bathing and general recreation. In addition, there are several smaller public beaches along this coast owned by towns or villages. Some long-range thoughts on how these problems might be met are presented later in this section under Prospects and Potentials.

Coastal erosion and tidal flooding were analyzed earlier as a selected problem. In this sector, erosion is considered critical on most of the South, East and North Shores (136). It is minor on the Westchester and backbay shorelines. Along the Atlantic, the shoreline has moved significantly over the past century and a half. The tip of Fire Island has swung alternatively seaward and shoreward a half mile. Because of hurricanes, storms and a southwestward littoral drift, which moves 600,000 cubic yards annually by Fire Island inlet (136) the ocean shoreline has been eroding in recent years at an average rate of about 3-10 feet a year. On the North Shore the rate has been slower, about 1-2 feet a year for the last century. Current corrective measures include periodic beach renourishment on the South Shore and protection of the bases of eroding bluffs on the East and North shores by building up a small protective beach or, if that is not feasible, by armoring methods using riprap or bulkheads.

In terms of 1970 dollars, the recurrence of the tidal flood of record, the 1938 hurricane, would inflict an estimated $170 million damage on the South Shore and about $2 million damage on the other shores in this sector.

A significant living resource problem here is general to almost every coastal area in the NAR: to identify the causes of the startling annual and longer range fluctuations in fish populations. Contributing factors have been suggested in an unknown order of significance, as overfishing, water temperature changes, pollution, wetlands destruction, and predatory relationships, including disease. It is easy, in the laboratory or in the field, to demonstrate the impact of these casual factors in extreme cases. Thus far, however, their incremental effects, individually or collectively, are unknown, at least to the degree that a systematic fishery improvement program can be confidently based upon them. For example, as late as 1950, the Long Island oyster harvest had an annual value of about $10 million. Today this value is only about 2-3% of that. Despite considerable research, major restorative measures have not been discovered.

One fact is clear, however, about 7-10% of the island's shellfish areas are currently closed to shellfishing for public health reasons due to bacterial contamination from domestic and duck wastes (112). Shellfish continue to grow and even thrive in these areas. By transplanting or depuration in accordance with established procedures, clams and oysters could, in many cases, be harvested for human consumption. Under current technology, the additional costs usually make these operations uneconomical. Nevertheless, it might often be far less costly to the community to subsidize the transplanting or depuration even 100% than it would be to pay the additional cost of maintaining salt water quality at its highest use classification (required for shellfish harvesting) instead of accepting the next lower level (required for bathing).

Another living-resources problem is caused by eelgrass. To the boater and shorefront user it is a nuisance which should be eradicated by any economically-feasible means because it closes small craft channels, fouls propellers and creates a stench when it dies, piles up and decays on the shore. To the commercial and sports fisherman and to the hunter, however, it is a valuable source of nutrient to fish and wildlife. A solution may lie in its balanced control--preserving or enhancing it in some selected areas and eliminating or minimizing it in others.

Transportation presents several significant problems. The availability of 80-foot deep, semi-protected water within a few hundred yards of shore at places along the North Shore in the vicinity of Riverhead prompted a proposal that a major offshore tanker offloading facility be developed there. The facility would meet broad regional needs discussed earlier under the selected problem on marine transportation. The proposal elicited vigorous public objection, as much from nearby Connecticut as from Long Island. The physical advantages of the site have been generally acknowledged, but the possible aesthetic and environmental disadvantages currently appear incompatible, to most, with the objective of improving the environmental quality of Long Island as a good place to live.

There are several other possible transporation problems of indirect but important marine interest.

° One relates to proposals for connecting the central or even eastern part of Long Island to New England by a trans-Sound bridge. Such a bridge would break the isolation now apparently preferred by most of the residents of the easternmost part of the island and sharply split its socio-economic orientation between New York City and New England.

° Another proposal aimed at resolving New York City's critical airport problem is to locate an airport on an island to be created in the western part of the Sound along the route of one of the bridges proposed here. Many environmental and economic objections have been raised.

° Lastly, with the opening of the Long Island Expressway to Riverhead, Peconic Bay is about three hours unbroken drive from New York City. Like most step improvements in accessibility, the Expressway is viewed as a mixed blessing. It does offer increased opportunity to enjoy Long Island. To those already able to enjoy the Island, it can be seen as an encroachment on the quality of their experience. To all, it reinforces the need for careful short-term and long-range planning.

The multiplicity and magnitude of these coastal problems, the public nature of the values involved, significant cost of solutions, the large population which will be influenced by these solutions and the many interrelationships between coastal and non-coastal concerns--point up the special need for comprehensive coordinated planning. To meet this need, the Nassau-Suffolk Regional Planning Board has formed a Marine Resources Council. The Council is partway through a six-step program of identifying and describing the problems, determining the knowledge required to resolve these problems, evaluating the adequacy of what knowledge exists, developing and implementing a data collection and research program to fill the gaps, and developing a management information system to facilitate planning and decision making (42).

Major Prospects and Potentials. A number of prospects and potentials are implicit in the previous comments--improve the fishery, improve water quality, capitalize on the capacity to assimilate thermal discharges, etc. However, only one will be selected here for emphasis. It is the prospect for planning and using the area's long and diversified coastline to make the Island an increasingly appealing place to live, notwithstanding the increased population and urban day visitors it will have to support.

This prospect was singled out because it most closly correlates with what seems increasingly to be the Island's major long-range strategic contribution to the region as a whole--not primarily as a source of fish, crops, minerals, power, or transporation or industry--but as residential space for wage earners who work in the metropolitan area of New York. To improve the area's performance in fulfilling this "mission," priority attention might be given to the area's quality of life.

The coastal resource is usually described as limited. However much might be done to improve each of Long Island's five coasts--the ocean coast, the two coasts of the backbays, the Sound coast and the eastern coast. Along the ocean there is ample space to repeat the Jones Beach type project many times to satisfy mass recreational needs. Of course, vehicular access would have to match the development. For those willing to sacrifice some of the unique experiences in ocean bathing, portions of the backbay coasts could be developed. A good example is Zack's Bay behind Jones Beach. The backbays themselves might be more fully developed as a good safe place to sail shallow-draft boats. For example, public launching areas with attendant facilities could cater to car-towed motor boats and small sail boats.

The quality of the North Shore beaches might be improved by dredged sand. More and better marinas and boat basins could cater to the larger craft which would sail on the Sound. More of the numerous bluffs overlooking the Sound could be made more accessible to the public.

All of these things require time and money. They must understandably compete against other worthy public needs. But if the priority is given it does seem that, for increasing human enjoyment, the coastal zone of this area has indeed numerous prospects and potential.

AREAS 12 AND 13 (NEW YORK CITY)

Area Characteristics. In Area 12, this sector consists of the Hudson Estuary. In Area 13 this sector consists of New York City and that part of Westchester County which borders the Hudson River. The part of Westchester County bordering Long Island Sound was considered in the preceding area summary along with Nassau and Suffolk Counties on Long Island.

The long Hudson Estuary exhibits significant salinity to the vicinity of Poughkeepsie and tidal influences extend as far north as Troy. The estuary is known for its aesthetic appeal. Behind a few narrow strips of sand, marsh and railroad track hugging the shoreline, the land rises sharply and falls away inland into rolling forested highlands. Scenic overlooks, large estates and historic and cultural landmarks abound.

The steep cliffs of the Palisades across from upper Manhattan mark a transition into the busy urban atmosphere. Much of the 290-mile shorefront is lined with piers, wharfs, and docks along the Harbor's bays and rivers. Behind the waterfront, urban structures dominate the view and symbolize the vigor of the commercial and industrial activity there. Numerous bridges, tunnels and airports give evidence to the intensity of flow of people and materials.

Oceanward of the Verrazano Bridge which marks the harbor entrance, the 28 miles of oceanfront is all beach. Ownership is 19 miles public, 8 miles private and 1 mile Federal (136). A net westward movement of sand along the barrier beaches of southern Long Island necessitates repeated dredging to maintain channels to New York Harbor.

There are a few undeveloped areas on the shore of New York City that approximate a natural condition. The extensive tidal marsh of Jamaica Bay shelters migrating waterfowl and small marine life, ringed as it is by major airports, and city beaches, parks and open space, and urban development. The waters of the East River, Harlem River and the Lower Hudson are essentially unproductive of marine life because of the commercial development along the shores and because of the waste load of contaminants they carry. Migratory fish do pass through the Lower Hudson to reach spawning grounds and nursery grounds in Haverstraw Bay, above the New Jersey line.

The population and economic data for the New York area read as a familiar litany of superlatives. In 1960, 8.6 million persons residing in New York City represented roughly one-fifth of the population of the NAR study area, with a density of 24,783 persons per square mile. This does not allow for the numbers that daily commute into the city. Population density in Westchester County was at 1,860 per square mile in 1960. (Appendix B - Economic Base).

Population growth to the year 2020 is expected to lag the national growth rate at 80%. Per capita income was a substantial 25% above the national average, but this figure masks the extreme cases of poverty that have historically constituted part of the New York demographic makeup.

New York City is a regional, national and international center of trade. One-fourth of the nation's import-export volume passes through docks of the Port of New York including its New Jersey part. One-fourth of the nation's wholesale trade is conducted in New York, much of which is associated with the port. The city is a leading center of banking and financing of industrial and commercial enterprises. Manufacturing in the city is concentrated in apparel, printing and publishing.

Also concentrated in the city are cultural, communications, governmental and educational institutions and facilities.

Employment in 1960 for the five boroughs and Westchester County was proportioned 28% in manufacturing 67% in services and 4% in contract construction. By 2020, the largest increase in employment expansion is expected to occur in service industries at the expense of the manufacturing sector.

Major Coastal Uses. The Port of New York, which includes New York City and the adjacent parts of New Jersey, is the largest port complex in the United States. It handles three times the tonnage of all West Coast ports combined. Within the North Atlantic Region it handles twice the tonnage of the next largest port system, the ports along the Delaware Estuary. Within the Port of New York, however, the annual growth rate of the New York City share has dropped over the period 1955 to 1968 to only 0.4% annually. Because of the relative advantages of the New Jersey ports for accommodating containerized freights and bulk products, future growth will most likely occur on that side. Waterborne commerce between Albany and New York City is declining at an accelerating rate. It consists of fuel and construction materials. Passenger pleasure cruises traffic in New York ports nad dwindled; pleasure cruises now commonly originate at southern ports for Carribean cruises. (See the earlier analysis of the selected problem of marine transportation and Appendix K-Navigation).

Coastal waters of the area are heavily used to dispose of liquid sanitary wastes, solid wastes and waste heat from industrial cooling water discharges. Many state and Federal agencies and the Interstate Sanitation Commission are involved in controlling and reducing wastewater discharges. The waters offshore of the area are used as repositories for certain solid wastes generated in New York harbor such as incinerator residue, sewage sludge, dredged spoils, flyash and construction rubble totalling 9.6 million tons in 1968 (45). Several large thermoelectric generating stations located in New York City use the coastal waters for condenser cooling.

Land use in New York harbor and along the lower Hudson River is predominately commercial and industrial whereas along the ocean front of New York City the predominant shoreline uses are residential and recreational. Annual attendance at beaches in New York City in recent years exceeds 30 million, even though water quality for swimming has been marginal at times. Staten Island beaches draw about one million annually, Coney Island about 10 million and the Rockaway beaches about 20 million.

Major Coastal Problems. Solid waste disposal is becoming a critical problem in this area. New York City and Westchester County have for some years now relied on landfill for disposing of municipal trash and garbage. The capacity at present landfill sites is expected to be depleted within the next four to seven years (51). Additional landfill sites on the coastline are not politically feasible. Additional conventional incineration facilities are ruled out because of air pollution and prohibitive costs of controlling the emission of pollutants. Two solutions that hold promise for New York City are compaction-railhaul-landfill for disposal in outlying counties, and compaction-baling-coating for dumping offshore onto the continental shelf, possibly in conjunction with some degree of material separation and recycling.

It remains to be determined what effects ocean dumping may have on marine ecology. Other forms of solid wastes mostly chemicals and sludges are already being dumped at designated areas offshore under permits from the Supervisor of New York Harbor, U.S. Army Corps of Engineers. Concern raised over the impact of offshore dumping has prompted several studies.

Rotting timbers from abandoned piers have created a nuisance to navigation and have littered the shoreline. The Corps has proposed a program for eliminating this nuisance by removing the debris from the shores and waters of the Port of New York.

Another major coastal resource problem in this area is the deteriorating recreational value of the shoreline and waterfront. Recreational fishing and swimming on otherwise suitable shores are discouraged because of microbial pollutants, and discoloration and odors from chemical pollutants. The southern shoreline of Staten Island and Brooklyn south of the Narrows are the principal areas of concern. Another form of pollution impairing recreational value is the littering and cluttering of the shore by junk oil, abandoned cars and rotting timbers from disintegrating waterfront structures. The recreational plan for New York cites the need for new beach front development to relieve congestion at existing facilities on Long Island. The Tri-State Regional Planning Commission recommends priority action in the older central areas and that portion of the unmet needs in these areas be transferred to sites in mid-distance counties with special transporation (rail, bus) to make these sites more accessible.

The problem of coastal erosion and flooding is especially significant in this area. This heavily used ocean front has been reliably surveyed for nearly 150 years. The historical pattern has been one of great change with alternating periods of erosion and accretion of up to 7 feet per year in places. Extensive groins have produced a relative period of stabilization in recent years. The littoral drift transports sand generally southwestward at a rate of 300,000 to 600,000 cubic yards passing a given point in a year (136).

The U.S. Army Corps of Engineers has estimated that if the design hurricane should strike New York Harbor, it would cause, in 1958 dollars, about $2.5 billion in direct damages and a similar amount in indirect damages. About 60% of this damage would occur in the New York City parts (Area 13) of the Harbor and about 40% in the New Jersey part of the Harbor (Area 14). No plan could prevent all these damages, but the potential for very great benefits is evident and is now being studied. Just the provision of emergency plans for excavating and protecting the New York City subway system from inundation and a disastrous loss of life could produce truly tremendous benefits someday.

As indicated at length in the earlier analysis of the selected problem of marine transportation, the rapid evolution towards economical, very deep-draft tankers and dry-bulk carriers presents special problems to the Port of New York, part of which is located in Area 13. The inadequate depths of existing channels, the probably prohibitive costs of deepening the channels substantially, possible environmental effects, social problems related to possible dislocations of industrial bases closer to a future deep-water facility, and other intraregional implications -- all point to the need of a cooperative study involving Federal agencies and the affected port authorities to work out a long-range solution.

Major Prospects and Potentials. Solutions to the upgrading of the quality of coastal waters involve large capital outlays for sewage collection and treatment facilities for industrial as well as domestic sources. The capital costs for sewage collection and treatment facilities as projected to the year 2000 by the Tri-State Transportation Commission amount to 6.4 billion dollars for the whole Tri-State region (122). Information on the improved water quality expected was considered earlier under the analysis of the selected problem of water pollution. In New York City, the highest priorities for upgrading water quality have been assigned to Jamaica Bay, Coney Island-Brighton Beach, the Upper East River, and the adjacent portion of Long Island Sound, and Raritan Bay off Staten Island. As piers and wharves are abandoned awaiting redevelopment, the problem of floating and beached debris can be expected to become more severe. However, with the growing need for commercial and residential floor space, redevelopment of phased-out waterfront should accelerate. Already plans for redeveloping the waterfront of Lower Manhattan have been proposed whereby landfill behind the bulkhead line will provide office and residential land with an assessed valuation approaching $2 billion, or about $3-5 million an acre (101).

The Gateway National Recreational Area is an innovative proposal to expand the recreation potential of Lower New York Bay. The Area would develop a number of existing state and Federal coastal holdings for various forms of recreational activities -- swimming, boating, viewing, environmental education --- and connect these parks with some form of water-based transporation (144).

The use of coastal waters of New York City for dissipating waste heat from power plants will not likely increase in the future for several reasons. Air pollution, adverse thermal effects, and competing uses of land may prompt future power plants to be built in less urbanized areas. This was discussed earlier in more detail in the analysis of the selected problem of thermal effects.

In summary, the New York City area will accommodate increased economic development primarily in service industries, concentrating commercial and industrial uses in Manhattan and Brooklyn. It will disperse residential, open space and outdoor recreational shoreline uses to peripheral areas.

SUBREGION D

This subregion consists of the coastal zones of New Jersey and Pennsylvania and the Delaware Bay coastal zone of Delaware. The coastal zone of each of the three areas -- 14, 16, 15 from north to south -- is considered herein terms of its area characteristics, major coastal uses, major coastal problems and major prospects and potentials.

Table U-21 summarizes some broad judgements as to the relative importance of the selected problems in this subregion.

TABLE U- 21

PROBLEM PROFILE IN SUBREGION D

Problem ✱ Highly significant ✳ Significant ● Relatively insignificant	Living resources	Conservation of wetlands	Non-living resources	Water pollution	Thermal effects	Solid wastes disposal	Recreation	Marine transportation	Coastal erosion and tidal flooding
Area 14	●	●	●	✱	●	✳	✳	✱	✳
Area 16	●	✱	✱	✳	✳	●	✱	●	✱
Area 15	✳	✳	●	✱	✳	●	●	✱	●

AREA 14

Area Characteristics. This area includes the basins of northeastern New Jersey beginning with the shore of the Hudson River and including the Hackensack, Passaic, and Raritan basins, Newark Bay and the New Jersey portions of the channels around Staten Island -- Arthur Kill and Kill Van Kull. The area is characterized by low flat topography, and extensive tidal marshes, many of which have been reclaimed with landfill. The cliffs of the Palisades along the Hudson comprise the major natural topographic feature in the coastal zone. Intensive urban development -- piers, skyscrapers, bridges -- is the predominant characteristic of the area.

Over two-thirds of the population in New Jersey reside in the area, 4.1 million in 1960. Population density is high, reaching 13,752 per square mile. By 2020 the population of the area is expected to double to 8.4 million inhabitants. (Appendix B - Economic Base)

Employment in the area was 1.6 million in 1960 and is expected to double by the year 2020. In 1960 manufacturing accounted for 40% of employment and services accounted for 58%. The major urban centers in the area are Newark, Jersey City and Paterson-Clifton-Passaic. Manufacturing industries were principally machinery, electrical products, primary and fabricated metals, chemicals, and food products. Employment in natural resource extraction industries - mining, fishing and agriculture - was only 0.9% in 1960 and is expected to decrease by 50% by 2020. Manufacturing by 2020 is expected to increase by 15%. and the largest increase 163% should occur in the service industries to constitute 77% of all employment by 2020.

Personal income in 1960 was well above the national average in the area (by 23%) and projections indicate that it will remain so, decreasing slightly to 15% above the national average in 2020.

Major Coastal Uses. Waterborne and solid waste disposal, marine transportation and urban land use are of special importance in this area's coastal zone.

The tidal waters are heavily used for the disposal of large quantities of liquid wastes from municipal and industrial sources.

A very substantial portion of the area's coastal zone is given over primarily to solid waste disposal. The Hackensack Meadowlands comprising 21,000 acres, roughly three-fourths the area of Manhattan, is located north of Newark Bay and contains 12 active sanitary landfill sites used by over 100 communities for dumping garbage and rubbish. Comprehensive planning by the Meadowlands Development Commission will maintain at least the present capacity for solid waste disposal and may allow for other uses compatible with solid waste disposal. (81)

Extensive port facilities line most of the area's waterfront. The containership terminal at Elizabeth, maintained by the Port of New York Authority, is the largest of its kind. It is a key to the continued attraction of a large international general cargo trade in the future. Expansion of container facilities is more likely in New Jersey than in New York City because of the availability of space for storage and marshalling.

Major Coastal Problems. Water pollution within the area has been severe; it is seen as a consequence of the vigorous industrial activity in the area. Nearly all of the major coastal water bodies in the area are currently classified as suitable for navigation and industrial use, and not suitable for fishing, boating or swimming. According to goals for upgrading water quality in the region as indicated by the Tri-State Transportation Commission most of the coastal waters in Area 14 will retain the present designation through 2000 (122). The Hackensack River, the Hudson River and the Raritan River are given priorities for upgrading to use for fishing and boating.

In the Arthur Kill, the chemical oxygen demand (COD) in industrial waste discharges exceeds the biochemical oxygen demand (BOD). Other wastes in the form of phenols, oils trace metals and heat reflect the diversity of industrial effluents in contrast to the effluent from municipal treatment facilities. In terms of BOD, the industrial wastes feeding into Raritan Bay have been estimated to be equivalent to the municipal wastes of more than one million people. (122)

The industrial pollution load from Area 14 as a whole has not yet been determined. Therefore an appraisal of the extent to which the waterways are being used for this purpose is not possible at this time. Efforts by the Federal Water Quality Administration to prepare such an inventory nationwide may eventually provide the needed information.

Research on BOD levels in upstream portions of the Raritan, Passaic and Millstone Rivers indicates that less than 40% of the observed organic loadings can be attributed to known point sources. It is not known whether this relationship holds for the lower reaches of these rivers where industrial plants are concentrated. (162)

As indicated atlength in the earlier analysis of the selected problem of marine transportation, the rapid evolution towards economical very deep draft tankers and dry bulk carriers present special problems to the Port of New York. The problems are particularly significant in that part of the port which is located in Area 14. The Port's existing channels are far shallower than these new vessels require. The cost of deepening is probably prohibitive and environmental considerations can pose problems. If deep draft facilities are located elsewhere, major economic dislocations in Area 14 could occur. A cooperative study involving Federal agencies and the affected port authorities is needed to work out a solution possibly involving overland movement of crude oil from a new offloading facility, say in Lower Delaware Bay, to the sites of the existing refineries.

There is little critical erosion in Area 14, but tidal flooding can be a significant problem. Although flooding does not occur frequently, a rare, meteorological predictable storm in this intensively developed area could produce major damage. The U.S. Army Corps of Engineers estimates that if the design storm were to hit this area, damages would reach $2 billion, about half direct and half indirect.

Another problem is the difficulty in providing opportunities for outdoor recreation, primarily swimming and picnicking. The coastal zone of the area is not expected to be able to accommodate much, if any, of the demand for swimming. The outdoor recreation plan for the state of New Jersey anticipates that the swimming needs of nearly 100,000 persons in 1980 and 229,500 persons in 2000, will not be accommodated by facilities in the area. The solution proposed in the action plan recommends pool facilities and improved access to expanded beaches outside of the area, both inland and along the oceanfront. (83)

Other coastal recreational activities such as boating and sport fishing may be possible if the quality of coastal waters on the periphery of the area is upgraded and other obstacles of safety, congestion, shoreline access and aesthetic blight can be overcome.

Major Prospects and Potentials. Population and economic projections indicate that the already heavy urbanization of this coastal zone will intensify. The greatest growth is forecast in the service industries such as transportation, financial, business and professional. Coastal activities dependent upon high water quality and the natural environment will have to be accommodated outside the area, most likely along the coast of adjacent Area 16.

AREA 16

Area Characteristics. The coastal zone of this area includes the shore of Raritan Bay between the Raritan River and Sandy Hook, and the ocean shore from Sandy Hook to Cape May.

The 20 miles of shorefront on Raritan Bay is characterized by high bluffs and marshlands fronted by narrow beaches intersected by numerous tidal creeks. Ownership is divided -- 13 miles private, 7 miles public.

The 125 miles of ocean shorefront in this area consist entirely of beach. Most of the beaches are on long sandy barrier islands. Behind the beaches are backbays, salt marshes and meadows that extend several miles inland in some places. The pattern of oceanfront ownership is 80 miles public, 30 miles private and 15 miles Federal (136). The shores of the backbays are largely wetlands, but there are more beaches there than along other backbays in the North Atlantic Region. Shoreline ownership along the backbays is largely private.

The 1960 population of the six counties in the region was 650,000 with about half of this concentrated in Monmouth county in that portion nearest to the New York metropolitan area. The resident population density is 900 per square mile in Monmouth county and 272 for the remaining counties in Area 16. Employment in the six counties is expected to increase from 230,000 in 1960 to 870,000 by 2020. Over the same period manufacturing employment for the counties is expected to increase by 114%; other employment is expected to increase by 328% by 2020. (Appendix B-Economic Base)

However, demographic and economic characteristics of the coastal communities of the Jersey shore differ significantly from the counties as a whole. The Jersey shore is almost exclusively a recreation-based economy. Historically the ocean beaches have been vacation grounds for residents of the Greater New York and Philadelphia areas. The economy of the shore is thus heavily dependent upon the millions of summer visitors attracted by natural and man-made recreational and resort facilities. Income from the areas' resorts in 1963 amounting to $1.8 billion (84) was one of the largest sources of business income in the state. Because of the dependence on tourism during the summer season from June through September the coastal communities are subject to high unemployment during the winter season. For example, in January 1965 over 13% of the work force of Atlantic City was unemployed. Population statistics belie the extremely high influx of people in the summer. For instance, Stone Harbor's resident population of 830 exceeds 18,000 during the summer. On a peak summer weekend Asbury Park accommodates 200,000 visitors, and Atlantic City accommodates 500,000 visitors to their beaches and board-walks (84). Most of the resident population in the shore area is located in resort towns on the barrier beaches; however, since there is virtually no vacant land remaining on the barrier beaches from Sandy Hook down to Cape May, most of the population growth and development between 1950-60 has occurred on the mainland behind the barrier beaches. The proportion of residents over sixty-five is higher for the coastal resort counties than for the rest of the state indicating the attractiveness for persons in retirement.

Major Coastal Uses. Recreation is the predominant use on the Jersey shore. Of its natural resources, 125 miles of wide ocean beach provide surf bathing and fishing. Deep-sea sport fishing expeditions depart from many of its ports. Fishing and shellfishing are popular throughout the bays and sounds behind the barrier beaches. Pleasure boating enthusiasts benefit from the Intracoastal Waterway whose entrance at Manasquan Inlet at the Northern end of Barnegat Bay passes behind the barrier beach through bays and sounds to Cape May and continues on to Florida. Over 200,000 boats used all or part of the Intracoastal Waterway in 1963.

Man-made recreational resources in the form of boardwalks, promenades, amusement parks and night clubs add to the attraction of the larger resorts such as Atlantic City and Asbury Park.

Most of the out-of-state visitors to the Jersey shore come from metropolitan New York and Philadelphia, but increasingly more of the out-of-state visitors come from other parts of the North Atlantic Region.

Land use in the coastal zone is for the most part residential and recreational. The barrier beach is so heavily developed that virtually no vacant beachfront exists, exceptions being state- and federally-owned beaches and scattered vacant parcels around inlets. Commercial land use is concentrated in the central business districts of the larger resort towns, and adjacent to the boardwalks and promenades. Industrial land use is minimal throughout the shore area, most of it occurring along Raritan Bay. Some federally controlled lands no longer of military value such as Fort Hancock on Sandy Hook are being phased out. New Jersey leases part of Sandy Hook beachfront to accommodate intensive day-use recreational demand, but even these expanded facilities are filled early on summer weekends. The marshlands and portions of mainland facing the barrier beaches have only recently begun to be developed as lagoons providing marinas, homes and boating facilities. Large portions of the coastal marshlands have already been reserved as state and federal wildlife refuges.

Major Coastal Problems. Coastal erosion and flooding are major problems in this area. Critical erosion occurs along parts of the Raritan Bay - Sandy Hook Bay shores and along most of the oceanfront. The ocean shoreline in this area has a history of alternating movements seaward and shoreward. In the past two decades some reaches have been moving at a rate of up to 12 feet a year oceanward, and others by 16 feet a year landward. One area in particular, the southeast tip of Pullen Island has been accreting at an average rate of 300 feet a year over the last decade. The more severe storms move considerable quantities of sand too far offshore to be returned between storms by ocean swells. In such an unstable environment groins and jetties must be sited with unusual care. Even the backbay shorelines experience some erosion damage, although its prevalence and intensity are much less than along the ocean.

Damages from a recurrence of the tidal flood of record in this area have been estimated by the U.S. Army Corps of Engineers at about $260 million. Nearly half of this damage would be along the heavily populated coastline along Raritan and Sandy Hook Bays.

In tests off Sea Girt, New Jersey, the U.S. Army Corps of Engineers has demonstrated the technical feasibility of renourishing beaches periodically by pumping some of the vast quantities of sand which have been surveyed offshore onto the beaches. Contract experience in Florida employing an underwater crawlcutter is expected to further advance the technology and economic feasibility of offshore pumping. Although additional studies are required, it also appears that from an environmental viewpoint offshore sources are preferable to alternative sources -- backbays and inland. (125)

A related problem of dune erosion along the Jersey coast has been attributed in part to the imprudent siting of houses and structures on unstable frontal dunes. McHarg has shown that by prohibiting any form of development on the frontal dunes, vegetation is more likely to take hold to stabilize and trap dune sand and prevent undue erosion. (69) Unfortunately more prudent development of the barrier beaches to reduce dune erosion is hampered by existing development. Considerable additional information on dune stabilization, of particular applicability to New Jersey's oceanfront, was presented earlier as part of the analysis of the selected problems of coastal erosion and tidal flooding.

Another major problem on the New Jersey shore is the conservation of wetlands.

Concern has been expressed for the ability to maintain the quality of these seemingly abundant natural recreational resources in the face of inevitable development. The marshes along the mainland are undergoing development. The lagoon-type development is expropriating large areas of marshland important to fish and wildlife. The state already has legal measures to control development on marshlands, claiming riparian rights to lands beneath navigable waters. Through the Bureau of Navigation in the Department of Environmental Conservation the state may sell or lease its interests in tidal lands.

<u>Major Prospects and Potentials</u>. The abundant recreation resources of the New Jersey shore have the capacity to absorb much of the demand for coastal recreation not only within the state but for the metropolitan areas of New York and Philadelphia, for the region and

even the nation. With careful planning the available resources of the Jersey shore could continue to accommodate a diversity of recreational pursuits along the surf, broad beaches, the backbays and adjoining marshlands. A trend of an increasing number of permanent residents, retirees and commuters will help to stabilize seasonal unemployment.

In the near future the coastal waters of the New Jersey shore may be utilized for dissipating waste heat from thermal electric power plants. The proximity to load centers and the abundance of cooling water along the coast are important considerations in power plant siting. A planned nuclear installation at Barnegat will have a capacity of 1.8 megawatts. Other plants are likely to be proposed.

AREA 15

Area Characteristics. The coastline of Area 15 consists of Delaware Bay and the Delaware River to the head of tidewater at Trenton. Above Penns Grove the waterfront is largely industrial and commercial on both banks.

The 85 miles of shoreline from Penns Grove to Cape May on the New Jersey side consist of about 50 miles of wetlands and 35 miles of narrow sandy beach frequently marshes. Ownership is apportioned about 45 miles private, 20 Federal and 20 public. A sparse 12 miles of the shoreline is residential (136).

The 82 miles of the Delaware shoreline from Willmington to Cape Henlopen consist almost entirely of marshes in the north and of a narrow strip of sand beach fronting more marshes in the south. Ownership is divided about 57 miles private, 14 public and 11 Federal. Except for 9 miles for public recreation and 2 miles for commercial purposes, the entire shoreline is undeveloped.

Shoreline use is primarily wetland conservation. Little bathing occurs in the Bay and shoreline fishing is generally poor. Bay fishing by boat has improved in recent years and is now considered to be good.

The climate of the basin is generally mild, with sustained periods of extreme temperatures seldom lasting more than three or four days. Annual mean air temperature ranges from 50°F in the upper mountainous reaches to 54°F on the Coastal Plain at Wilmington. The average annual precipitation on the entire Delaware River Basins amounts to about 44.6 inches, ranging from about 40 inches near Delaware Bay to about 60 inches in the Catskill Mountains. The prevailing winds are from the southwest in summer and from the northwest in winter.

The annual fresh water flow into the Delaware Estuary from above Trenton averaged over the 57 year period ending in 1969 is 11,371 cubic feet per second. Most of the flow originates in the upper basin where rainfall is heavier. The Schuylkill River, largest tributary of the Delaware, enters the Estuary at Philadelphia contributing an average annual discharge of about 2,900 cfs. Approximately 100 smaller tributaries flow into the Delaware Estuary or Delaware Bay with a combined annual freshwater discharge of about 5,000 cfs.

The population of Area 15 in 1960 was 6.4 million, heavily concentrated along the Trenton-Philadelphia-Wilmington portion of the New York to Washington urban corridor. By 2020, the area's population is expected to increase to about 12 million. (Appendix B - Economic Base).

Per capita income for the basin's population is high, 12% above the national average, but by 2020 this is expected to decline relative to the national average per capita income. Employment at a level of 2.5 million will probably nearly double by 2020, with largest increases in service industries and lesser increases in manufacturing (36%). The lower portion of the basin containing metropolitan Philadelphia and Wilmington has over two-thirds of the employment in the basin (1.8 of 2.5 million), with 44% in the service industries, 36% in manufacturing and less than 2% in agriculture, forestry, fisheries and mining.

The Delaware River Basin Commission operates under an interstate-Federal compact giving it broad responsibilities for planning and managing the water and related land resources in Area 15. The Commission is composed of the governors of the States of Delaware, New Jersey, New York and the Commonwealth of Pennsylvania, and the U.S. Secretary of the Interior.

Major Coastal Uses. Marine transportation is important in Area 15. All of the fourteen major ports on the Delaware River are located above the head of Delaware Bay, between Wilmington, Delaware and Trenton, New Jersey. The industries along the Delaware River depend upon navigation for the importation of iron ore and petroleum, other bulk commodities and general cargo. Iron ore, crude petroleum and residual oil accounted for over half of the tonnage moved overwater in the Delaware Basin. Collectively the Delaware River ports handle a total volume, 116 million short tons in 1968, second only to the Port of New York in this region. Volume has grown steadily although the rate of growth has declined in recent years. The ports are served by a channel of over 100 miles from the Atlantic, through Delaware Bay to Trenton, New Jersey. The Chesepeake-Delaware Canal connects these ports with those along Chesapeake Bay. Ports on Delaware Bay itself are minor and their volume has declined sharply over the last quarter of a century.

A major factor affecting the Delaware Estuary is its use for waterborne waste disposal. Most of the waste load originates along the reach between Trenton and the head of Delaware Bay. In a 1964 survey 1.8 million pounds of oxygen-demanding material were found to be generated daily by numerous industries and municipalities in this reach. These wastes receive varying degrees of treatment prior to discharge. The river water is also used extensively for industrial cooling.

A third major use of the estuary is municipal water supply. Over 200 million gallons a day are withdrawn directly from the river to supply over 50% of Philadelphia's freshwater supply. A potential threat to this water supply is the salt water front, the position of which fluctuates with the freshwater inflow from upstream. Low flow augmentation to stabilize this front is particularly desirable here.

A fourth major coastal use is wetlands conservation. As stated earlier, most of the peripheral land around Delaware Bay is wetlands - tidal flats, salt marsh and salt meadow - often extending inland for several miles. A large portion of these wetlands has already been acquired by state and federal conservation agencies and by private conservation groups. (114) The Bombay Hook National Wildlife Rrefuge contains 12,000 acres of prime wetland habitat for migrating waterfowl, and Prime Hook National Wildlife Refuge will contain 5,000 acres when acquisition is completed. (114) One reason for the large amount of dedicated land is that these wetlands in their present state are unsuitable for most other forms of development. Superior shoreline recreational facilities are found close by on the Atlantic coast, and most through transportation bypasses the area along the urban corridor to the west, the closest bridge crossing being at Wilmington. Coastal wetlands along the Chesapeake-Delaware Canal and along the industrialized shore of the Delaware estuary are relatively small in size and deteriorating in quality for wildlife habitats as a result of development and the deposition of dredging spoil along the banks.

Commercial and sport fishing, hunting and water contact recreation are not considered major uses of the Delaware Basin at the present time although these resources could be developed and promoted for future use and enjoyment.

Major Coastal Problems. The single most important coastal problem in the Delaware Basin is water pollution below Trenton from municipal and industrial sources. Water quality above Trenton is generally and relatively excellent. (147) Waste loads from primarily municipal and industrial sources are expected to double in the period 1964-1975 and to increase by 5 1/2 times by 2010. (These milestone years used for the Delaware Estuary Study by FWPCA approximate NAR milestone years 1980 and 2020). The Delaware Estuary Study reported that in 1964, as a result of waste discharges, dissolved oxygen is almost completely depleted in some locations, and gases from anaerobic decomposition of organic deposits are produced regularly during the summer. Coliform bacteria concentrations are very high in the same stretch of river. Acid conditions in the river caused by industrial waste discharges have been observed for several miles above and below the Pennsylvania-Delaware State line. Surface discoloration due to the release of oil from vessels and surrounding refineries is a common occurrence from Philadelphia to below the State line. Overflows of combined sewerage systems result in a discharge of fecal matter and other offensive solids, floating material, and miscellaneous flotsam which would normally be trapped by the treatment plants. This material in the Estuary represents one of the few remaining types of discharges that can affect the aesthetics of the Estuary by visible evidence of raw sewage. The net result is a polluted waterway which depresses aesthetic values, reduces recreation, sport and commercial fishing, and inhibits municipal and industrial water uses.

The effects of waste loading in the future can be significantly influenced by the large Tocks Island project upstream. To the extent that freshwater is diverted out of the Delaware Basin, dilution capacity in the river is reduced. On the other hand, to the extent that the higher flows are impounded upstream and released during periods of low flow, dilution capacity can be greatly improved. In addition to stabilizing waste dilution capacity and the Philadelphia water intake conditions, the control of freshwater inflow can also benefit the small and badly depleted oyster fishery in the Bay. The effects of salinity concentrations on oysters and the net flow of freshwater from Chesapeake to Delaware Bay through the enlarged Chesapeake and Delaware Canal are discussed in the next area analysis on Chesapeake Bay.

The activities directly affected by water pollution are the potential water contact recreation users who are now barred or discouraged from swimming in the waters of Delaware estuary. The effects of pollution on the waters of Delaware Bay are not known from the information available, but it is suspected that water pollution has been one of the factors responsible for the pronounced decline in the fish and shellfish industry of the bay. Other possible factors include the oyster drill, MSX disease, over-harvesting, and increased salinity concentrations.

Costs for achieving approved water quality standards and maintaining the improved level to 2020 are estimated at about $12 billion (see Appendix L-Water Quality and Pollution).

A second major problem in Area 15 is in the field of marine transportation. As indicated at length in the earlier analysis of the selected problem of marine transportation, the evolution towards economical, very deep draft tankers and dry bulk carriers presents special problems to the Delaware port system. It has been generally accepted that the problems of deepening the estuary channel to accommodate the supervessels are overriding because of rock, the near-surface aquifer and tremendous costs. There may be substantial socio-economic implications, locally and regionally, if the area's industrial base cannot somehow find a way of incorporating the major economics implicit in the use of the new supervessels. A regional offshore offloading facility in Lower Delaware Bay has been proposed; however, the national, regional and local values involved and the economic, social, safety, environmental and jurisdictional interrelationships all point up the need for a careful cooperative study by the Federal agencies, the affected port authorities and probably others.

Shoreline erosion is a relatively insignificant problem in this area. It is confined to a few localties such as Broadkill Beach and Lewes on the Delaware Shore and Wildwood Villas on the New Jersey shore.

According to estimates of the U.S. Army Corps of Engineers a recurrence of the tidal flood of record would cause damages, in 1970 dollars, of about $60 million, mostly in the Philadelphia area.

<u>Major Prospects and Potentials</u>. The possible development of a deepwater offloading facility in Lower Delaware Bay, and the considerations involved in reaching a decision, have been mentioned above and in the earlier analysis of the selected problem of marine transportation. Whatever decision is reached, including no decision, the long-term effects on the Philadelphia area are likely to be substantial.

As the knowledge of the relationship between wetlands and marine life improves, the possibility of managing the Bay's extensive wetlands to make them truly valuable in raising the currently low level of fish populations in the Bay might also be expected to improve without sacrificing other values. Anticipated long-range improvements in the quality of Delaware River inflows should also work in the direction of improving the abundance of marine life for sport and commercial purposes.

Nearer to Philadelphia, shoreline recreation should become more attractive as water quality improves if better public access is provided and shoreline conditions are improved by sandfill.

SUBREGIONS E AND F

The coastal portions of the other subregions have been considered earlier generally on an area-by-area basis. For the coastal zone of subregions E and F, however, such an approach would undesirably fragment the subregions' dominant coastal feature, Chesapeake Bay. Since the Bay is best treated as a coherent system, a fragmented area approach to its description and analysis would produce tedious repetition and possible loss of ability to see the Bay as a whole.

Accordingly subregions E and F have been subdivided for subsequent description and analysis into two compartments, or sectors, differing sharply from each other in their physical, biological and socioeconomic dimensions and hence in the type and intensity of their coastal problems.

The first sector consists of Chesapeake Bay and the estuarine protions of its major tributaries. This sector thus includes that part of the coastal and estuarine portions of Areas 18 and 21 which abut Chesapeake Bay and all of the coastal and estuarine portions of Areas 17 (Susquehanna), 19 (Potomac) and 20 (Rappahannock-York).

The second sector consists of the coastal zones of Delaware, Maryland, and Virginia which face the ocean. It thus includes a part of Area 18 and a very small part of Area 21.

Each of these two coastal sectors is considered herein in terms of its area characteristics and major coastal problems, uses, prospects and potentials.

Table U-22 summarizes some general judgement as to the relative importance of the selected problems.

TABLE U- 22

PROBLEM PROFILE IN SUBREGIONS E AND F

Problem ✱ Major * Significant ● Relatively insignificant	Living resources	Conservation of wetlands	Non-living resources	Water pollution	Thermal effects	Solid wastes disposal	Recreation	Marine transportation	Coastal erosion and tidal flooding
Area 18 - 21 Chesapeake Bay (Overall)	●	*	●	✱	✱	●	✱	✱	*
Area 17 (Susquehanna)	*	●	●	✱	*	●	●	●	●
Area 18 (Upper bay)	✱	*	●	✱	✱	●	✱	✱	●
Area 19 (Potomac)	*	●	●	✱	●	●	*	●	*
Area 20 (Rappahannock-York)	*	●	●	*	●	●	●	●	*
Area 21 (James)	*	●	●	✱	*	●	●	✱	●
Areas 18 & 21 (Ocean)	●	*	●	●	●	●	✱	●	✱

AREAS 18-21 (CHESAPEAKE BAY PORTION)

Area Characteristics. The Chesapeake Bay is the largest estuary on the Atlantic coast and one of the most important in the world. The Bay receives water from a drainage basin of 65,476 square miles. Its shoreline, based on the criteria of the National Shoreline Study (136) is about 2,800 miles, two-thirds located in Maryland. The Bay itself is about 200 miles long and its width varies from about 4 to 35 miles. The water surface of the Bay and its tributaries is about 4,400 square miles; the surface of the Bay itself is about 2,200 square miles. Its average depth to head of the tide is about 21 feet and its deepest hole is 174 feet off Kent Island.

The Bay's largest tributary is the Susquehanna, the largest river on the Atlantic coast of the United States. The Susquehanna drains 42% of the basin and provides about 50% of the Bay's total influx of freshwater and about 80% of the flows into the upper portion of the Bay. The Potomac, which drains 22% of the basin, provides the largest of the Bay's many large sub-estuaries; it is 115 miles from Washington to the Bay proper. Like the rivers to the south, the Potomac has always been heavily laden with silt and its net water movement is sluggish. The Rappahannock, York and James River basins together drain 24% of the basin and also form large sub-estuaries. The James is navigable by commercial shipping as far upstream as Richmond.

Salinity increases from zero at tidewater to about 32-35 parts per thousand (ppt), the range of seawater, at the Bay's mouth. Salinity also varies significantly with the seasonal inflow of fresh water. For example at the end of the normal low flow period from August to October, the 3.5 ppt ("slightly brackish") isohaline (a line of equal salinity) extends as far north as Susquehanna Flats near that river's mouth. At the end of the annual high flow period this isohaline is about 30 miles south, almost to the William Preston Lane Junior Memorial Bridge which connects the eastern and western shores.

Circulation is very complex. It is influenced by the 0-3 foot tidal range, freshwater inflow, the Chesapeake and Delaware Canal and density flows induced principally by sharp salinity gradients. Primarily in the summer, but also in the winter the freshwater on top and the salt water on the bottom are layered and flow in opposite directions. Vertical mixing occurs principally in the spring and fall.

Geologically the Bay is underlain by unconsolidated sedimentary formations 7,500 feet thick in places. The shore may be characterized as a coastline of submergence with its typical submerged river channels and thick mantle of fairly recent loose sedimentary deposits, wetlands and very erodable bluffs.

Of approximately 1,900 miles of Maryland shoreline about 280 are on the Bay proper and the rest are on the tributaries. The Maryland shoreline consists almost entirely of extensive wetlands on the eastern shore and banks, and banks, bluffs and wetlands on the western shore. Less than 1% (15 miles) of the shore can be considered beach. Ownership is divided about 1670 miles private, 200 Federal and 30 public. Most of the Federal ownership is concentrated in wildlife areas on the eastern shore and in several military installations on the western shore such as those at Aberdeen Proving Grounds, Edgewood Arsenal, and a number of Navy installations.

The Virginia shoreline of approximately 900 miles includes only a very few, small scattered beaches except for some near Hampton Roads and on the southernmost 25 miles of the Delmarva Peninsula. Most of the remaining shoreline is marshy. Many of the marshes, especially on the peninsula, are very brackish. Ownership is divided about 735 miles private, 100 public and 65 Federal. Most of the Federal property is concentrated in military installations in the vicinity of Hampton Roads. Of the 900 miles, only 40 are for public recreational use. Except for the commercial and military facilities in the ports, essentially all the remainder is undeveloped marshes, banks and bluffs.

On the western side of Chesapeake Bay, population density increases markedly as the coast is approached. For example, 1970 population densities in the upper, middle and tidal portions of the Potomac Basin (Area 19) were 42, 62 and 297 people per square mile respectively. In the coastal zone itself, population densities are very uneven. Thus the western shore accommodates two of the largest urban centers in the nation: the Baltimore-Washington area and the area around Hampton Roads. During the time span of the NAR study these two concentrations are expected to merge into the Boston-Norfolk megalopolis. In marked contrast, the eastern shore is now and is expected to remain relatively unpopulated.

Similarly, economic activity, on both a total and a per capita basis, is now and is expected to remain heavily weighted toward the western shore. In both subregions E and F employment is expected to follow long term trends with increases expected in services and in the chemical, paper and metals industries. Declines are expected in the textiles, petroleum refining, agriculture, forestry, fishing and minerals industries.

The Bay has had a major imprint on our nation's past. Not coincidentally, many of our most important historical landmarks are located immediately adjacent to the Bay's subestuaries. These include

Williamsburg and Jamestown, where our colonial existence began
Mt. Vernon, the home of the Father of our Country
Yorktown, where our national independence was won
Washington, our national capitol, and
Ft. McHenry where our National Anthem was written.

Major Coastal Uses. All of the major coastal uses are found in varying degrees in Chesapeake Bay. This section will highlight some of the ways these uses apply to the Bay. Considerable additional general information on each use has already been provided in the earlier analysis of selected problems. Further information about each use can be found later in this summary of Chesapeake Bay under the headings of "Major Coastal Problems" and "Prospects and Potentials".

In the value of their commercial fish catch, Virginia and Maryland rank ninth and tenth among the nation's 24 oceanfront states with an annual catch of $18 and $17 million respectively.1/ Essentially all of the catch for the two states comes from Chesapeake Bay, not the Atlantic Ocean off their coasts. Within the North Atlantic Region, the Bay provides a quarter of the catch. Only Massachusetts, fourth, and Maine, eighth, rank above Virginia and Maryland.

The total value of the Bay's catch has risen from $25 million in 1950 to $35 million in 1967 although individual species have, of course, shown the sharply different fluctuations so characteristic of marine fisheries. In 1967, the most important species economically were the oyster, hard crab, menhaden, soft clam, soft crab, and hard crab in that order. The oyster accounted for about half of the total value. Many of about 200 recorded species are permanent residents. Other more predominantly ocean-oriented species spend significant parts of their life cycles in the Bay in spawning, nursing or feeding or in passing through on the way to or from freshwater.

With the exception of some sand and gravel little in the way

1/ For consistency, all commercial fishing statistics cited in this section are for calendar year 1967 (155). The catch varies considerably from year to year and place to place. In general, 1967 was a good year nationally with a total deckside value of $438 million, the third highest dollar value in history. About 8% of this national total came out of Chesapeake Bay.

of non-living resources is extracted from the Bay. About 12 million short tons of sand, gravel and crushed rock were reported to have moved through Bay ports in 1968. (138) How much of this was extracted from the Bay is not known, but even if most of it came from this source, the volume is not large enough to classify non-living resource extraction as one of the major uses of the Bay.

Waste disposal is one of the most prominent uses of the Bay and much concern has been voiced in recent years lest the Bay's assimilitative capacity be overtaxed. The great and rapidly growing population concentrations on its western shore, associated industrial activity and the relatively sluggish movement of its silt laden tributary rivers all combine to point up the importance of controlling this use knowledgeably. Control is especially important in the finger-like, slow-flowing, urban-fringed sub-estuaries like the Potomac and the Patapsco where pollution problems are the worst.

The 1,800 megawatt Calvert Cliffs nuclear power plant about 30 miles south of Annapolis is the second largest in the NAR. This plant uses the waters of the Bay to dissipate very large quantities of waste heat.

To satisfy outdoor recreation needs, a large body of water with several thousand miles of coastline immediately adjacent to the southern part of what is expected to become the largest megapolis in the world might be expected to play an important role. The Bay is generally filling this need for pleasure boating, sports fishing and hunting. According to Appendix K (Navigation) about 200,000 pleasure craft are located in the Bay area and about 600,000 are expected by 2020. Nearly half these totals can be considered "registered" as defined by the current registration requirements of Maryland and Virginia. Private facilities should be able to satisfy the marina demand, but some increase in public launching facilities, may become necessary. Sports fishing is a major recreational use of the Bay and also a major industry. The Bay is also one of the principal wintering areas for water fowl on the Atlantic Flyway. Each year it winters nearly a million ducks and geese. About half of the Bay's 300,000 acres of salt marshes are managed for this purpose. (153)

The Bay has not been satisfying other forms of outdoor water based recreation and aesthetic needs such as beach lounging, bathing, water skiing, and visual aesthetic satisfaction. Its performance in satisfying these needs will continue to be disappointing unless the causes for the deficiency are remedied, possibly as suggested later under "Major Coastal Problems".

Marine transporation is focused on Hampton Roads and Baltimore which ranked third and fourth among the NAR ports in total tonnage in 1968. Several studies have been made on economic impact of these ports. One study (1942) concluded that the total, "direct" and "indirect" economic impact of the port of Baltimore was about $1 1/2 billion in 1966 and represented about 12% of Maryland's gross state product. Another study (34) of the Virginia ports concluded that in 1968 port and harbor related activities generated 94,000 jobs and wages of $0.63 billion. Indirectly an additional 131,000 jobs were generated. In total, one out of every eight jobs in Virginia were directly or indirectly related to the State's port and harbor activities. Although such conclusions have to be accepted with some caution because of difficult problems of definition and methodology, it is undoubtedly true that these two port complexes have a very substantial impact on the economic well being of the people who live in these two states. Significant dredging is required to maintain and improve the channels to these two port complexes and other important but lesser ports such as Richmond. Associated problems and prospects are discussed later in this section.

Several Navy facilities, especially those in the Norfolk and Annapolis areas, are dependent upon their coastal locations and contribute significantly to the Bay economy. Several Army installations, most only partially dependent upon their coastal location, also contribute importantly to the Bay economy. The concentration of military installations around Washington, D.C. is related primarily to the nearby Pentagon.

Major Coastal Problems. As indicated in Table U-22, of the nine major coastal problems selected for special analysis in the appendix, five can be considered as highly significant in the Bay area. These problems, listed in the same order as they were analyzed are living resources, water pollution, thermal effects, recreation, and marine transportation.

The first major problem is how to increase the commercial fish catch in a sustained way. Among the many things which influence the commercial fish catch are --

- Institutional problems of the industry such as the economical utilization of a common resource and antiquated laws and methods preserving the industry's labor-intensive tradition.

- Population fluctuations by species. The fluctuations are inadequately understood at least in the sense that significant corrective action can be taken. Some progress is being made in controlling the effects of the microscopic paraste MSX by developing disease-resistant seed oysters.

- Difficulties in capitalizing economically on the theoretically outstanding potential of mariculture, especially with shellfish.

• Water quality to include not only control of toxic and oxygen depleting wastes but also preserving or beneficially altering the Bay's salinity regime. Water quality is also impaired by sedimentation. Sedimentation may well have caused loss of the oyster beds upstream from Poole's Island. Susquehanna Flats is becoming a problem area and probably has lost much of its fishery value by becoming progressively more shallow -- there is still about 1 million cubic yards of new sediment entering from the Susquehanna River annually.

Because the measures necessary to maintain or change salinity concentrations can have a very great influence on other uses and on the long range preservation of the Bay <u>and</u> its entire tributary area, amplifying comments are needed. (63) and (64)

The size of the relatively fresh pool of water maintained in the upper Bay varies greatly as indicated earlier. Its most important determinant is the size and duration of the last high flow in the Susquehanna. Also important is the effect of the Chesapeake and Delaware Canal. The cross section of this canal is being increased from 27' x 250' to 35' x 450'. This enlargement has been estimated to cause an increase in the net quantity of fresh water flowing from the Chesapeake to the Delaware of about 1,600 cubic feet per second (CFS). This is about 5% of the Susquehanna's average flow of 35,000 cfs, but it can become much more significant during the more critical low flow periods.

Insofar as marine life is concerned salinity changes in either direction have both good and harmful effects, even for a single species. The oyster is a good example. A <u>reduction</u> of freshwater input, especially during the highest flows would result in moving the limits of oyster growth far upstream. This is because the higher upstream salinities would be preferred by the oysters and the occasional severe flood, if its peak flows were reduced, would not kill or smother in sediment the oysters living along the upstream limit. On the other hand, an <u>increase</u> of freshwater input, especially during the highest flows, provides a down Bay barrier against oyster predators. For example, the MSX parasite requires a minimum salinity of 15 ppt. Thus oysters, more obviously than most life, occupy a niche. Ideally, to optimize oyster growth some changes in natural conditions on either extreme might be helpful. Thus the lowest flows could be increased and a dependable minimum be maintained, and the highest of the high flows could be diminished enough to avoid destroying oysters growing along the upstream limits and yet not enough to significantly affect the downstream predator limits.

The example of the oyster can be generalized. Whenever a natural set of conditions has existed for a long period of time some life will have become dependent upon this regime -- with the probable exception of the relatively rare occurrences which intrude upon the tolerance limits of the species under consideration. Whether it is desirable to modify these limits depends upon many things such as adequate understanding of the effects, the feasibility of modifying the natural conditions, and the consequences to others in benefits, losses and potential benefits foregone.

The Susquehanna River Basin Comprehensive Study foresees increased consumption losses in that basin in the future -- equivalent to a little more than 10% of annual flow by the year 2000. These losses would be caused, in order of importance, by cooling for thermal power plants and municipal water supply especially for the Baltimore area during periods of low flow. Possible transfers out of the basin to supply nearby metropolitan areas would cause additional losses.

With these and other considerations in mind the Susquehanna Study has evolved as an interim, safe-sided balancing act, emphasizing (1) the need for a sophisticated model to monitor and evaluate changes which may be found to be desirable, (2) regulatory authority to effect those changes, (3) a small cautious diminuation ("flood skimming") of the average annual high flows of about 1/2%, and a slight increase of about 2% of the average annual low flow 1/ and (4) endorsement of local practices such as the policy at Conowingo Dam, near the river's mouth of releasing additional water when dissolved oxygen downstream drops below 5 ppm at a time when there is a large concentration of fish there.

This general strategy seems fitting and logical, but the essential need for much more knowledge of the effects on marine life is clear. It needs to be known with much greater accuracy and confidence, what the effects are, both good and bad, on marine life when environmental extremes are dampened out to various degrees.

Among the most important factors that influence the Bay's margine life are the extensive wetlands along much of the Bay's 2,800-mile shoreline. According to one estimate of 603,000 acres of wetlands and shoal areas evaluated as important to fish and wildlife," 5,000 have been lost since 1950. This is an annual loss rate of about 0.04%, one of the lowest rates for similarly large areas in the continental United States. (153) Maryland has estimated that it has been losing its coastal wetlands in the past three decades at the rate of nearly 400 acres a year -- an annual loss of about 0.1% of the state's 307,400 acres of wetlands. A quarter of this loss is ascribed to natural erosion and natural succession and

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1/ These are changes in the average monthly flow during the lowest and highest months. The effects on the most severe floods and droughts would be appreciably greater.

the remainder to man, primarily for landfill, dredging, spoil disposal and agricultural drainage.

The second problem considered herein is how to reconcile the need to dispose of waterborne waste products with the uses of the Bay. A very valuable use of the Bay lies in its capacity to assimilate waterborne wastes better than most currently known alternatives. However, this capacity is obviously limited by the quantity and toxicity of the waste. Currently it is not adequately known what this threshold is and what the incremental effects of departing from it are. Of the many uses of the Bay, those most influenced by waste disposal are fishing and swimming. Currently about 42,000 acres of shellfish grounds are closed because of pollution. Pollution also fosters plankton blooms, especially prominent in the Potomac below Washington. (153) Pollution is generally concentrated where flushing and dilution action is the poorest. However, unless and until other problems cited later under recreation are resolved, improvement in water quality will probably have relatively little effect upon swimming in the Bay.

A third major problem considered herein is thermal effects. The heavy population and industry on the Bay's western shore, the escalating requirement for electric power, and the Bay's superior ability to absorb waste heat when compared with other local alternatives, all are combining to produce a concentration of heat dissipating power plants along the Bay's western shore. A recent study (14) of the thermal effects of locating a 1,800 megawatt nuclear plant at Calvert Cliffs concluded that the rate of surplus heat produced by a modern plant of this size is equivalent to about 1/3,000 of the noon rate of natural radiation received by the Bay in summer. Comparisons such as this lend useful perspective, but, as the study pointed out, it is important to recognize that a nuclear plant's heat output is concentrated on the surface of a relatively small part of the Bay. About two-thirds of the heat added by the plant is dissipated in evaporation. The remainder heats the water or is lost in other processes such as advection to the Atlantic Ocean. The implications of each additional plant are currently and properly being carefully evaluated. However, unless power demand tapers off unexpectedly or unless significant technolgoical breakthroughs materialize, it remains clear that the Bay performs far better than inland waters as a receptable for waste heat. As pointed out earlier in the special analysis of thermal effects, cooling towers offer an alternative, but their overall environmental side effects can be significant.

A fourth major problem considered herein is how to satisfy outdoor recreation needs. Its proximity to population centers makes the Bay a candidate for greatly increased recreational demand. Currently most of the recreational use is in the form of boating and sports fishing which are strongly interrelated. The heavy demand for skin contact recreation such as swimming, clamming, and waterskiing is almost completely unsatisfied because of several obstacles.

• Seasonal considerations make the resource attractive for these purposes only about a quarter of the year. Probably very little can be done about seasonality although some thoughts are offered later in the discussion at Areas 18-21 along the ocean.

• During the one season of the year when outdoor bathing is attractive the sea nettle or jellyfish migrates up the Bay. The migration apparently follows increased salinity concentrations caused by seasonal reductions in fresh water inflow. The sea nettle inflicts severe stings on anyone who enters the water.

• As pointed out earlier, only about 1% of the Bay's nearly 3000 miles of shorelines is suitable for beaches. In the Virginia part of the Bay this percentage rises somewhat, maybe up to 4-5%. If the other obstacles could be solved, this one could also be overcome. It ought to be feasible for example, to create sandy beaches artifically. Only a small part of the total extensive shoreline should be able to satisfy a major part of high-density beach demands.

• Also as pointed out earlier, only about 3% of the Bay's shoreline is publically owned. Here too, if the other obstacles to the use of the Bay for high-density water contact sports could be overcome, this access problem could also be resolved through planning and publically-financed acquisition at carefully selected sites.

• In the finger-like subestuaries adjacent to large population and industrial concentrations, pollution also limits bathing opportunities. Even if and when municipal and industrial pollution are brought under adequate control, the heavy silt loads of many of the rivers would still provide and aesthetic detriment to bathing. (See Appendix Q - Sediment and Erosion)

• For those who prefer surf action, the Bay can never be as attractive as the oceanfront. However, to many this diminution of recreational experience would be small when weighed against the added cost and nuisance value of fighting crowds to gain ocean access.

As formitable as these obstacles are, there seem to be currently available ways of offsetting or minimizing all of them except the sea nettle. Its control or elimination in an ecologically and economically acceptable way could open up a substantial close-in summer recreational resource to pent-up demand adjacent to one of the largest existing and future concentrations of people in the nation.

A related use which could be better satisfied in the Bay area is aesthetic visual satisfaction. Except when one crosses a tributary subestuary or one of the Bay bridges, or when one makes a special effort to visit the coast, a resident could go for weeks or months without even knowing the Bay is there. With the exception of the above few obvious bridge-crossing necessities, most of the daily travelled ways of the populace seem to be oriented to keep the Bay out of sight. It would not be easy, but increased effort to identify the relatively few visual promentories in the Bay area and route some of the more heavily travelled roads through some of these promentories could provide a most welcome daily aesthetic uplift to many people. Obviously care would have to be exercised in preserving the ammenities and avoiding unattractively long diversions in heavily travelled routes. Nevertheless an objective to bring the Bay into the visual awareness of many people daily should be partially attainable over time.

A fifth major problem considered herein is how to accommodate the Bay area to the expected trends in marine transporation. The special earlier analysis of marine transporation dwelt in some length on the potentially large economic advantages of accommodating more of the world's fleet of deep draft vessels in the NAR. The accommodation of very large tankers does not appear particularly applicable to Chesapeake Bay. However, insofar as dry bulk cargo is concerned, two of the three largest port complexes in the NAR are located on the Bay. These are Hampton Roads which dominates the region's substantial coal export trade and Baltimore which ranks with the Philadelphia area as the region's largest importer of iron ore. The significance of the fixed investments in the current inland coal feeder systems linking the Virginia ports with the inland coal fields, and the large steel plants currently in the Baltimore area probably overwhelm possible economies attainable by moving to deeper water even if available. The problems of making the Hampton Roads and Baltimore facilities accessible to the deep draft vessels are substantial, but solutions are at least conceptually possible. (See Marine Transporation under Special Problems) The 57-foot depth clearance of the Chesapeake Bay Bridge-Tunnel limits the size of Bay vessels, but as brought out in Figure U-11 this limitation will still allow large dry bulk carriers to enter the Bay. If these very deep draft dry bulk carriers can be accommodated in an environmentally and economic acceptable way, the overall impacts on the economic well-being of the Bay area and the nation could be very substantial.

A second type of marine transporation problem in the Bay area stems from coastwise shipping. The Chesapeake-Delaware Canal across the narrow, 16-mile neck of the Delmarva Peninsula shortens the water distance between Baltimore and Philadelphia from about 400 to 100 miles and avoids exposure to the ocean. As pointed out earlier, the enlargement of the cross section of this canal currently underway might markedly increase the salinity of the upper Bay by diverting part of the Bay's freshwater input into Delaware Bay. Such salinity change is potentially harmful to some marine species. The biological consequences need to be carefully evaluated. The evaluation will be difficult because of the very complex three-dimensional nature of the water interchange and existing biological uncertainties.

At a public hearing held by the Public Works Committee of the House of Representatives in April 1970, testimony was presented by the Director of the Chesapeake Bay Institute, Johns Hopkins University to the effect that all indications pointed to a minimal change in salinity of the upper Bay and by the Director of the Chesapeake Biological Laboratory, Natural Resources Institute, University of Maryland, that the indicated salinity changes would appear to have little ecological effect. The Corps of Engineers has initiated studies of this situation with a view to taking steps, coincident with the completion of the work on the Canal, to eliminate any detrimental loss of fresh water if such should appear probable. These studies involve research to be performed under an $800,000 contract with the Chesapeake Biological Laboratory, Natural Resources Institute, University of Maryland, plus investigations by Corps of Engineers personnel costing approximately $250,000.

A third type of coastal problem related to marine transportation is the disposal of dredging spoil. It is becoming increasingly difficult to obtain clearance to dispose of this spoil anyplace -- on land, on any part of the Bay's 2,800-mile shoreline, on any part of the Bay's 300,000 acres of salt marshes or in any part of the Bay's 4,400 square miles of water. Environmental side effects of dredging were considered under the earlier analysis of marine transportation and a number of type solutions were suggested. Considering the very small part of the Bay which is dredged, the volume of material moved in comparison with the natural background rate of erosion-produced silt, the relative ease with which potentially desirable side effects might be produced (wetland enlargement, improved flushing, desired shoreline fill, etc.) and the importance of the navigation channels, it would seem that solutions should be able to be reached. Perhaps a few carefully located diked deposition areas could be established. When the areas are eventually filled, new wetlands, or islands, or shorefront is created, whichever is most desired. Solutions such as this, with joint Federal-local funding are currently being practiced in the Great Lakes. Also, it is noted that the State of Maryland has authorized expenditure of $13 million for the construction of a 100 million cubic yard contained disposal area in proximity to Baltimore Harbor. The disposal area is in the preliminary design stage.

Tidal flooding is generally not a significant problem in the Bay area. However, several hundred acres of low elevation land in shoreline areas is inundated occasionally by storm or unusually high lunar tides in Somerset and Dorchester Counties. This problem is somewhat exacerbated by the trend of gradually rising sea levels. The forces of nature in the Bay are much less violent than those nearby on the Atlantic coast. Because of this fact, however, the Bay shoreline has not developed the same compensating resiliancy. Long range geological factors associated with a coastline of submergence have also contributed to the increasing exposure of an easily erodable shoreline. Consequences are a loss of shorefront property and an increased turbidity and filling of the Bay.

About half of the 1,900 miles of Maryland's Bay shoreline is subject to erosion. During the century, 1845-1942, the net loss of land was about 25,000 acres on nearly 40 square miles. (136) The western shore experienced about 25% of this loss and the eastern shore about 75%, a distribution roughly equivalent to their respective coastlines. Dorchester, Somerset and Talbot Counties, in that order, have had the greatest net loss. The 15 most critical miles, with historical erosion rates greater than eight feet annually, are located on Kent Island, Poplar Island and Tilghman Island on the east shore and Point Lookout and St. Clements Island in St. Mary's County and Cove Point in Calvert County on the west shore. With a few exceptions, studies have revealed that there currently is no economical solution. Only 5% of the Maryland shoreline is now protected to varying degrees mostly with the help of state financial support. Solutions vary with intended use. Thus sand replenishment is probably best in beach areas and riprap and bulkheads are probably best in other areas. Ecological considerations present some problems. On the one hand, many of the wetlands which are biologically important are prominent erosion casualties. On the other hand, the protective methods where justified must be designed with ecological considerations in mind.

The problems in the Virginia part of the Bay are similar with the most critical erosion occuring along the lower south shore of the Potomac Estuary and the Bay front of Areas 19 and 20. In Virginia, as in Maryland, almost all of the shoreline is privately owned and thus currently ineligible for Federal assistance.

Almost all of the planning and management considerations presented earlier under "Planning and Management" apply with particular weight to Chesapeake Bay because of the Bay's special importance, size and interstate nature. A major long-range, multiple-use, interagency Federal-state, comprehensive Chesapeake Bay study has been authorized under the leadership of the Army Corps of Engineers. An important associated feature of this study is a large 6-acre hydraulic model proposed to be located at Matapeake, Maryland on land donated for this purpose by the State. Mathematical models will be used to complement the hydraulic model for such purposes as evaluation of socio-economic information and dissolved oxygen deficits. Consideration was given to utilizing a completely mathematical model, but the study concluded that these types of models, although of increasing sophistication and value, can not handle the complex three-dimensional flow analysis necessary in solving many of the Bay's real problems. 1/ For example, a mathematical model can not predict changes in salinity and velocity distributions resulting from deeping of the Bay's navigation channels. Such changes could have important ecological ramifications. 2/ Significant further action on the study and its related model must await Federal appropriations.

One of the stated purposes of the Chesapeake Bay study is to consider, on the basis of the information acquired, the appropriate institutional device to carry on continued comprehensive planning and to manage the Bay. The key decision makers should be the two affected states which have jurisdiction over the Bay's bottom, shores and waters. Since any resulting formal inter-state institutional device will require Congressional ratification, its provisions and the extent of Federal participation will undoubtedly be carefully reviewed to reflect the Federal interest. Whatever the future institutional pattern may be, it is clear that it will have to consider the Bay's relationship with the important tributaries, many of which have major portions in nearby states. A possible way of integrating both the Bay and inland perspectives and still recognizing the currently proposed Susquehanna and Potomac Compacts has been suggested earlier under "Planning and Management".

Since 1969, Maryland has been undertaking a State interagency planning effort regarding Chesapeake Bay and its related resources. This study is pursuant to an Executive Order from Governor Mandel to the Maryland Department of State Planning. The study is focusing its efforts on identifying and developing the key elements essential for coordinated comprehensive planning and management of Chesapeake Bay.

1/ Currently there is no known three-dimensional mathematical estuarine model anywhere in the world. However, an effort is being made to develop one on the Connecticut River estuary.

2/ Currently there is some professional dispute over the relative merits of hydraulic and mathematical models. It seems conservative to conclude that each currently has distinct advantages over the other for analyzing certain parameters when site-specific considerations are introduced. If the values are high enough, both are probably necessary working in a complementary nature. Where values are less and conditions simpler, either or neither may be justified.

A detailed land use survey leading to the delineation of lands suitable for future growth and development, particularly those areas with multiple use capability, has been suggested as one of the essential steps in planning for the Bay area.

Major Prospects and Potentials. Proceeding from the broad overview of the Bay area just presented, the next step is to relate the Bay's prospects to the objectives established for the NAR study--national efficiency, regional development and environmental quality.

Activities designed to increase income and employment, in a way that does not merely represent the transfer of an activity from another region, are compatible with both of the first two objectives. Four major potentials for contributing to these two objectives can be cited.

- The Bay's productivity as one of the major fisheries on the Atlantic Coast might be enhanced through improved knowledge and development of mariculture, wetland management, water quality and other largely unknown factors influencing fish populations and through resolution of some of the institutional problems of the industry.

- With careful environmental controls including monitoring, the Bay's assimilative capacity to absorb waste heat from nuclear power plants can result in low power rates and thereby beneficially influence the cost of living. More importantly, this capability can serve as a magnet to retain and attract employment--providing industries for the region--and simultaneously contribute to the production of nationally needed products at lower costs and less environmental degradation than they can be produced at alternative sites with lower assimilative capacity.

- The Bay has a considerable undeveloped potential for satisfying part of the close-in outdoor water based recreational needs of a rapidly growing nearby population. Although heavily used for boating now, the Bay still has ample capacity to absorb the great number of pleasure craft which are too small for the ocean and too large and numerous for the limited nearby inland water bodies. Potential improvements in the commercial fishery cited earlier will further contribute to the attractiveness of sports fishing, already a very profitable enterprise. If the major problems cited earlier which currently limit beach and water contact sports, can be resolved, a new seasonal industry could be developed. From an economic viewpoint, as distinguished from environmental quality considerations discussed below, increased boating and sports fishing might be expected to be more significant than beach and water contact sports because the dollars spent per participant in the former two greatly exceed the latter.

If the problems of accommodating large dry bulk carriers at Hampton Roads and Baltimore can be overcome, the Bay has the potential for satisfying major regional and national needs for the import and export of bulk commodities, especially ore and coal, in greater quantities at significantly reduced costs.

The Bay has a potential for contributing substantially to the environmental quality objective in several ways. The improvement of the fishery, in addition to its possible economic impacts on commercial and sports fishing cited earlier, can also improve the environmental quality of the Bay area. If realized, the possible large increase in the use of the Bay for beach and skin-contact reaction will greatly improve the environmental attractiveness of the Bay to a large number of people, much more than economic effects would indicate. The Bay's aesthetic appeal can become more meaningful if it can be brought into the frequent visual awareness of much of the people who live in and travel through the area. Shoreline attractiveness might be preserved and improved through adoption of planning and management measures which provide some form of coordinated public cognizance and control.

AREAS 18 AND 21 (OCEAN)

Area Characteristics. This sector includes the Atlantic coastal areas of the states of Delaware, Maryland and Virginia. About 120 miles of the ocean front is on the Delmarva Peninsula and 25 miles extend from Cape Henry south to the North Carolina line. All of the ocean front is beach. In Delaware and Maryland it takes the form of long, low, narrow barrier beaches fronting a series of embayments with infrequent narrow inlets connecting them to the ocean. The Virginia shoreline is less uniform. It varies north to south from barrier island, mainland, small buffer islands, mainland and barrier beach. The major embayments are Rehoboth Bay in Delaware, Assawoman Bay in Delaware and Maryland, Sinepuxent Bay in Maryland, Chincoteague Bay in Maryland and Virginia, Hog Island Bay in Virginia and Back Bay in Virginia and North Carolina.

Ocean front ownership is divided about as follows: 45 miles mostly in the southern part of the Delmarva Peninsula is private; 65 miles mostly on Assateague National Seashore and Wallops Island is Federal; and 35 miles mostly in Delaware and southern Virginia is public. About half the beach is used for public recreation. Most of the remaining half is undeveloped (136).

The back bays throughout this sector exhibit the characteristic pattern found almost everywhere throughout the NAR; their shorelines are almost all wetlands and have very little beach area, ownership is almost all private and the principal use is recreational, featuring small boating, sports fishing and wetlands appreciation. Many of the back bays in this sector are brackish.

Possibly because of its relatively isolated location even after the opening of the two major trans-Bay bridges, the significant year-around population and economic growth experience by nearby areas has generally bypassed this part of the coastal zone. Future projections contemplate far less growth for this area than for adjacent areas (Appendix B-Economic Base). The year-around inhabitants seem to prefer their area that way although there is some concern at the out migration of youth, especially those with college education.

Major Coastal Uses. The principal coastal use in this sector is recreation, including aesthetic satisfaction. The other coastal uses, although present, are much less important here. Little commercial fishing is done in these waters. About the only non-living resource extracted is sand and gravel in minor quantities although it is present in abundance. The large assimilitive capacity of the Atlantic relative to the limited wastes from a small, non-industrial population minimizes pollution problems except when outfalls are unwisely run into the small poorly flushed back bays. However, there is increasing concern about the ocean dumping of solid wastes off Area 18 by large cities such as

Philadelphia. There are no ports in the area nor any demand for coastal airports on land fill. National defense establishments are minor. Land use is important principally because of the land's value for enjoyment.

Major Coastal Problems. Of the nine problems selected for special analysis earlier, two--recreation, and coastal erosion and tidal flooding--are highly significant to this sector.

Recreation and aesthetics are dominant along this coast. Rehoboth Beach, Delaware; Ocean City, Maryland; and Virginia Beach, Virginia are each their state's major summertime mass outdoor recreational outlets. In 1969 Ocean City is reported to have accommodated nearly 13 million visitors (136). Spreading most of that crowd over 10 summer weekends conveys a picture of how intensely the beach is used.

Much of the ocean front in Delaware and Maryland and on Assateague Island in Virginia is open to the public. The remaining coast of Virginia is mostly privately owned except around Virginia Beach. Every fair summer weekend cars pile up sometime almost as far back as Washington, D.C. to cross the two-lane Bay bridge near Annapolis heading to Ocean City and Rehoboth Beach. Medium-density beach-oriented summer residences fill much of the available coastline near these resorts. The part of the Delmarva Peninsula south of Ocean City caters to low density recreation with emphasis on aesthetic satisfaction. The beautiful Assateague Island National Seashore is owned and operated by the U.S. Department of the Interior. Farther south on the peninsula, several barrier islands were recently purchased by a private conservation group from a developer to forestall a reported planned recreational-residential facility for up to 45,000 people.

Some ways the area can improve its ability to satisfy the inland recreational demand are:

° Improving accessibility. A new bridge is being constructed paralleling the previously mentioned two-lane Bay bridge near Annapolis.

° Preserving and enhancing aesthetic appeal by zoning control and other alternative means. Determining residential standards can be a difficult problem. It is hard to impose expensive standards on a cottage which will be occupied only 10 weeks of the year. Nonetheless, localities such as Rehoboth Beach have demonstrated the feasibility of constructing economical, simple, yet very attractive cottages. Zoning can cater to all values, not just the aesthetic one just cited. For example, there is a definite honky-tonk atmosphere about large parts of Ocean City which most of the younger set find "delicious." This has as much need to exist as its polar opposite, Assateague. The general rule which seems to apply is to recognize that all major points on the value spectrum need to be satisfied and portions of the coast should be developed so that many can "do their own thing." Indiscriminate, unplanned intermingling of these different recreational and aesthetic uses can dilute the satisfaction of all. Since there is less financial return to those who provide the lower density land uses, these in general might better be governmentally owned.

o Minimizing seasonality factors. Off season, the coast is a virtually deserted resource. Some effort is being made to minimize this gross inefficiency through appeals to the retired and through the construction of year-round convention centers at Ocean City and Virginia Beach. However, the problem is largely unsolved. Until it is, the provision of many really substantial facilities will remain economically impracticable. Demand can probably never be completely evened out throughout the year even if it were desirable to do so, but it is possible that the desolate beauty of the coast in the fall, winter and spring can be given more play which could relate to the current environmental thirst to escape. For example, recent emphasis on skiing, snowmobiling, naked outdoor beauty, spring and fall festivals and the like have given some enterprising inland areas a year-round clientele which was unimaginable several decades ago. One result has been the replacement of dilapidated summer shacks and inadequate sanitary facilities with comfortable, appealing accommodations. Perhaps ocean front areas such as this one will find imaginative coastal counterparts to these inland examples, and thus reduce the sharp seasonal imbalances between need and accommodation.

The problems of coastal erosion and tidal flooding were considered at some length in the earlier analysis of selected problems. Flooding is not a major problem in this area, but coastal erosion is. The long exposed coastline, frequent violent storms especially in the fall and winter, and a generally southward littoral drift combine to present severe coastal erosion problems.

Some of the barrier islands between Assateague Island and Cape Charles have been averaging a loss of 15-16 feet a year for at least a century. Hog Island lost 50 feet in a year. This is a foot a week! These islands are currently undeveloped, but their wild aesthetic appeal, wildlife habitat and usefulness as a protective barrier to the mainland might justify efforts to preserve them by sand fences, dune grasses or other inexpensive and environmentally compatible means.

The northern five miles of Assateague Island has been eroding at a rate of about 35 feet a year for the past 25 years. The erosion has probably been caused by the interruption of littoral drift by jetties protecting the inlet. These jetties have, for the same reason, produced a significant accretion in the Ocean City area immediately to the north greatly widening the public beach there.

Along most of the Maryland and Delaware Atlantic coasts annual losses range from about 3 to as much as 21 feet a year. The higher rate occurred in very limited stretches for only a few decades. In this vicinity shoreline values are much higher than those to the south. A particularly critical area is Bethany Beach, Delaware. Apparently a node exists there.

The littoral drift moves northward on one side and southward on the other. The result is erosion with little accretion at Bethany Beach and a growth of Cape Henlopen northward 3,850 feet since 1843.

Ameliorative devices in all these areas emphasize periodic sand replenishment and dune stabilization supplemented with local bulkheading. The estimated annual cost is about $3-1/2 million for the Delaware and Maryland reaches (136). This is equivalent to about 20 cents per summer visitor. Most of the beach erosion measures, especially the dune stabilization would also provide some added protection against tidal flooding.

Major Prospects and Potentials. Proceeding from the foregoing review of major coastal uses and problems, consideration can be given to the potentials of this part of the Atlantic coast in terms of the NAR Study's three basic objectives--national efficiency, regional development and environmental quality.

In terms of national efficiency and regional development, the sector's chief potential from a coastal point of view is recreation. The other uses of the coastal zone here do not appear to have a growth potential sufficient to impact appreciably upon regional and national need.

Considering recreation, little is gained here in trying to distinguish national efficiency from regional development. The overall coastal recreational outlook for the future is one of high demand, greatly exceeding supply almost everywhere. The further development of this particular sector's capacity to satisfy the demand will probably not reduce the number of coastal recreationers elsewhere. More likely, it will increase the opportunity for more people to enjoy the ocean. Similarly, if the increased use of Chesapeake Bay for beach and skin-contact sports should materialize as envisioned in the previous area summary, it will probably not affect the ocean front areas appreciably. Most of the people who would use the Bay would be those looking for close-in daily bathing. If the Bay were not available for this purpose, they would probably not expend the time, cost and energy necessary to reach the ocean front. The relatively few who would be diverted from the ocean front to the Bay would probably be insignificant in light of anticipated future demand.

Some thoughts on how this part of the coast might better satisfy future recreational needs were considered earlier. From the local development viewpoint, the problem is basically how to capture a more significant return from visiting recreationers. Basic strategies include:

o Increasing the number of visitors, with adequate controls to avoid deterioration of the recreational experience. Important here is the need to preserve or enhance the physical suitability of the beaches by adequate control and restorative measures.

o Increasing the stay-time of visitors. A two-day visitor will contribute much more than twice what a one-day visitor will contribute to the area's economic well-being.

° Improving the quality of the recreational experience in a way that visitors will pay for. Examples include attractive hotels, cottages, restaurants, excursions, and after-dark attractions.

° Extending the recreation season by means such as those suggested earlier. Examples include convention centers, year-round condominiums catering to the weekend and retirment trade, and the imaginative development of off-season attractions. Another possibility might be the development of ecologically oriented educational centers to be used as live-in facilities by schools in nearby metropolitan centers during the fall, winter and spring seasons, while providing regular visitor services in the summer months.

This sector of the Atlantic ocean front can contribute more to the NAR's environmental quality objective than it can to the other two objectives just considered. By any standard, this entire coastline is considered very beautiful. Much of it, especially in the lower part of the Delmarva Peninsula, is relatively undeveloped; so options still exist. As pointed out earlier, when Assateague National Seashore and the adjoining state parks were created, a big part of these options were picked up and allocated formally to low density recreation and aesthetic satisfaction. With careful planning and public controls the Atlantic ocean front of Delaware, Maryland and Virginia should be able to satisfy the full spectrum of recreational demand--from mass density beach bathing to medium density cottages to low density environmental satisfaction. Of course, all sectors will have to give up a little. Thus, the beach bather will be somewhat more crowded than he might otherwise have to be and the nature lover will have less area in which to roam than he would prefer--but these inconveniences are small in return for preservation of the spectrum of choice in a locale where such preservation is still possible.

BIBLIOGRAPHY

INTRODUCTION

This bibliography is based upon -

- An announced focus.
- A screening of a wide variety of documents.
- Judgement in making selections from the documents screened.
- Organization to facilitate identification of entries of interest to the user.
- A means of extending a line of inquiry beyond the scope of the bibliography itself.

The focus of this bibliography is pertinence to long range comprehensive planning in the coastal zone of the North Atlantic Region consistent with the scope of Appendix U- Coastal and Estuarine Areas of the North Atlantic Regional Water Resources Study (henceforth "NAR Study"). A brief reminder of the scope of the NAR Study and Appendix U is thus useful in establishing the context within which this particular bibliography is formulated.

The NAR Study is one of 21 similar studies under the aegis of the U. S. Water Resources Council. Together they comprise the entire United States including its coastal areas. The NAR Study is a comprehensive, interagency, joint Federal-state, long range framework plan for the water and related land resources to the year 2020 of the North Atlantic Region -- the area which drains into the Atlantic Ocean from Maine to Virginia inclusive.

Appendix U is based upon professional knowledge of the authors, numerous interviews and a review of a wide variety of documents on important coastal uses, problems and localities. Based upon the judgement of the authors, information from many of the documents screened was used in Appendix U. These documents were cited throughout the Appendix and became the basis of the annotated portion of this bibliography.

The bibliography is organized in three sections:

- An annotated bibliography. This section is the heart of the bibliography. As indicated above, it contains every document cited anywhere in the Appendix.
- A bibliography of bibliographies. It is provided for general reference purposes.
- An unannotated bibliography. It includes documents felt to be potentially useful during the early information acquisition stage but not finally used in the Appendix for various reasons such as scope, detail, duplication or currency.

The bibliography may be used in several ways:

- To build a general library, the documents in the annotated bibliography would provide a good initial base.
- To locate information on any particular use, problem or coastal area, a user should refer to the appropriate part of the Appendix and list the references cited therein. He can then turn to the annotated bibliography and, based upon the additional information contained therein, decide whether the document is of the type he is seeking.
- To pursue a given line of inquiry in further depth, several approaches are available:

  - Refer to other parts of the NAR Study. For example, although pollution is considered in some depth in Appendix U, a more comprehensive treatment will be found in Appendix L (Water Quality and Pollution) of the NAR Study.
  - Refer to the numerous references contained in almost all of the documents cited herein.
  - Refer to the bibliography of bibliographies to identify additional documents in almost any depth desired.
  - Scan the unannotated bibliography. The basic document identification therein is frequently enough to suggest the entry's central theme.

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An article summarizing the work of one of the study groups at a symposium sponsored by Massachusetts Institute of Technology. The group estimated the amount of oil being introduced into the world's waters by man in terms of tons per year and percent of the totals.

49. Interstate Sanitation Commission [New York, New Jersey, Connecticut]. Water Pollution Control Activities and the Interstate Air Pollution Program, 1969. New York, New York: Interstate Sanitation Commission, 1969.
A record of the water and air pollution activities of the Commission.

50. Johnson, Peter L. Wetlands Preservation. New York City: Open Space Institute, 1969.
A look into the problem of preserving coastal and other wetlands. Attention is given to economic considerations, methods of protection, legal regulations and proposed legislative controls. Although the report concentrates primarily on the situation in Long Island, the thoughts developed are applicable to any area. An extensive appendix contains many examples of current legislation regarding wetland protection in the New England area.

51. Keil, A. H., et al. Economic Aspects of Solid Waste Disposal at Sea. (Economic Aspects of Ocean Activities, Vol. III.)
A report on the problem of disposing of solid wastes, a

problem confronting large coastal cities. The report shows under what conditions solid waste disposal at sea becomes economic.

52. Krenkel, Peter A. and Parker, Frank L. (eds.). Biological Aspects of Thermal Pollution. Nashville, Tennessee: Vanderbilt University Press, 1969.
The formal papers and discussions presented at the first of two symposia on thermal pollution which were co-sponsored by Vanderbilt University and the FWPCA. The symposium was designed to bring together all those concerned with thermal pollution problems, to encourage an exchange of knowledge and experience, and to stimulate research.

53. Lauff, George H. (ed.). Estuaries. (AAAS Publication No. 83). Washington, D.C.: American Association for the Advancement of Science, 1967.
A compilation of research papers on estuarine research. Subject matter includes physical factors and geomorphology, sedimentation, microbiota, nutrients and biological production, ecology and populations, fisheries, and human influences.

54. League of Women Voters of the United States. "Where Rivers Meet the Sea." Facts and Issues. February 1970.
A discussion on estuaries outlining their nature and productivity, their problems from physical change and pollution, the requirements needed to halt their destruction, and the measures being taken by state and local agencies to protect them.

55. Lutjen, George P. "Marconaflo-the System and the Concept." Engineering and Mining Journal. May 1970.
An article reporting the successful use of the slurry process for moving iron ore to and from offshore platforms. The process is also reported feasible for coal and other bulk products.

56. Maine Coastal Plan. Phase 1, Interim Planning Report. Augusta, Maine: State Planning Office, February 6, 1970.
A progress report on the first part of a work program designed to study Maine's coastal area. Major attention is given to the formation of a Coastal Planning Advisory Task Force.

57. Maine Register 1969-70. Portland, Maine: Tower Publishing Company, 1969.
A compilation of statistical and organizational data on the state of Maine.

58. Maine State Park and Recreation Commission. Comprehensive Outdoor Plan for Maine. Portland, Maine: University of Maine Press, November 1966.

The study evaluates existing outdoor recreation facilities, assesses current and future recreation resource requirements, estimates the future demand to 1975, and provides immediate and long-range action programs for planning and development.

59. Marine Science Affairs - A Year of Broadened Participation. The Third Report of the President to the Congress on Marine Resources and Engineering Development. Washington, D.C.: Government Printing Office, January 1969.
   The National Council on Marine Resources and Engineering Development reports on its third year of activities, summarizing progress made during the past years, noting current accomplishments of various governmental agencies engaged in marine sciences, and describing Federal programs and budgets proposed for FY '71.
   The coastal zone portion of the report suggests ways of enhancing benefits by improved conservation and recreation, water quality, coastal engineering activities, planned use, multiagency programs, and a strengthened institutional framework. A program for the Great Lakes and multiple use of Chesapeake Bay are also discussed briefly.

60. Marine Science Affairs - A Year of Plans and Progress. The Second Report of the President to the Congress on Marine Resources and Engineering Development. Washington, D.C.: Government Printing Office, March 1968.
   A review of the programs and accomplishments of the Federal Government for utilizing the oceans more effectively. Focus is on those programs in marine sciences that expand international cooperation and understanding, facilitate transport and trade, accelerate use of food from the sea, encourage development of non-living resources, and utilize the resources of the coastal zone.

61. Marine Technology Society. Marine Technology 1970. (Transactions of the 6th Annual Conference & Exposition). Washington, D.C. June 29-July 1, 1970. 2 vols.
   Papers presented at the Society's 6th Annual Conference and Exposition. The Society is an international interdisciplinary organization founded to provide a means of communication among those concerned with the investigation, use and management of oceans. Its members are scientists, engineers, lawyers and others who work with the marine environment.

62. Marsden, Howard J. "The Regional Approach to Port Development Planning." Panel discussion on proposed Regional Port Studies by the Federal Government. Washington, D.C.: American Society of Civil Engineers, July 22, 1969.
   A discussion of federal activities, specifically related to port and harbor development. It briefly describes the functions and actions of the Water Resources Council, the U.S. Army Corps

of Engineers, the National Council on Marine Resources and Engineering Development, and the Commission on Marine Science, Engineering and Resources.

63. Maryland Department of State Planning and Maryland Department of Natural Resources. Maryland's Water Resources, Management Requirements in the Susquehanna Chesapeake Bay Basin. (Appendix B to the Susquehanna River Basin Coordinating Committee Study).

A study of Maryland's resource management objectives and water requirements relating to planning and development of the Susquehanna River and its estuary, the Chesapeake Bay.

This is an examination of the effects on water quality in Chesapeake Bay of possible changes in the quantity and quality of inflow from the Susquehanna to include dampening out high and low flow extremes, diverting flow to Baltimore for water supply, and consumptive upstream losses especially through thermal power uses. Changes in Bay water quality are relatively predictable, but the significance of these changes on marine life and on the uses of the Bay are still largely unknown. The report concludes that probably the best strategy is a cautious skimming of flood crests and an augmentation of the lower flows.

64. Maryland's Water Resources Management Requirements in the Susquehanna-Chesapeake Bay Basin Baltimore, Maryland: Department of State Planning, December 1969.

A discussion similar to item 63.

65. Massachusetts Department of Natural Resources. Division of Marine Fisheries. Annual Report. Boston, Massachusetts. 1969.

A year-end report of financial and research activities with appendices on shellfish and lobster catches, and statistics on 1968 weir-trap and pound net landings by species.

66. Massachusetts House. Second Interim Report of the Special Commission on the Boston Harbor Islands. (No. 4884.) February 1970.

A summary of the findings of a study undertaken by MIT faculty for the Massachusetts Legislature's Special Commission on Boston Harbor Islands. It highlights the potential uses of the Islands and outlines various alternatives for their development.

67. Massachusetts Public Access Board. Annual Report, July 1, 1968 to June 30, 1969. 1969.

A progress report and financial statement of the Board - a functioning body within the Dept. of Natural Resources whose main responsibility is to consider and then designate points of access to Massachusetts waters.

68. Maton, Gilbert L. et al. A Perspective of Regional and State Marine Environmental Activities. A Questionnaire Survey, Statistics and Observations. Springfield, Virginia: Clearinghouse, February 29, 1958. PB 177 765

A report presenting data and information resulting from a marine environment activities survey of the coastal states and the states bordering on the Great Lakes. The survey sought to identify organization, functions and perspectives of various governmental agencies involved in marine environmental activities.

69. McHarg, Ian L. Design with Nature. Garden City, New York: The Natural History Press, 1969.

A landscape architect and city planner explores the relationship between man and his environment. The author recounts how our natural environment has been polluted and destroyed by misuse of modern technology and demonstrates how and why ecological research and design should be used in determining future environmental planning and management.

70. Moore, J. Jamison (Executive Director, Modern Management, Beverly Hills). The Ocean: An Economic Perspective III.

A presentation contained in item 61. It discusses three general surveys carried on by this company concerning the progressive development of ocean oriented industries and marine activities. It concludes that the 70's will see an accelerated period of growth in the field of oceanography.

71. Murawski, Walter S. A Study of Submerged Dredge Holes in New Jersey Estuaries with Respect to Their Fitness as Finfish Habitat. New Jersey: Department of Conservation and Economic Development, October 1969.

An examination of the results of dredging operations in New Jersey estuaries with specific attention to abandoned borrow areas to determine the value of these holes as finfish habitat. Several water quality parameters were measured, and an analysis of the bottom muds for physico-chemical properties was made.

72. Nassau-Suffolk Regional Planning Board. Existing Land Use. (Comprehensive Plan Series). February 1968.

A survey of all existing uses of land, both public and private, in the counties of Nassau and Suffolk, New York, with the information tabulated according to municipality, and school district.

73. National Academy of Sciences-National Academy of Engineering. Committee on Oceanography and Committee on Ocean Engineering. Wastes Management Concepts for the Coastal Zone, Requirements for Research and Investigation. Washington, D. C.: National Academy of Sciences-National Academy of Engineering, 1970.

An evaluation of scientific and engineering requirements for research on effective coastal wastes management. It includes physical processes, chemical and biological factors, general recommendations and suggested priorities.

The report summarizes the state of knowledge of waste management with particular emphasis on monitoring systems. It presents a specific priority-oriented program of research and investigation with estimates of the minimum level of effort required.

74. National Water Commission Annual Report for 1969. Washington, D. C.: Government Printing Office, 1970.

A description of the Commission's activities from its organization in 1968 through the end of 1969. Major emphasis is on the formulation of their program of special studies.

75. New England Interstate Water Pollution Control Commission. Annual Report on Interstate Water Pollution Control. Boston, Massachusetts: New England Interstate Water Pollution Control Commission, 1968 & 1969.

A summary of the year's activities in water pollution abatement in interstate waters. It emphasizes the Commission's reevaluation of its authority, capability and future role in meeting the needs of the member states.

76. New England Marine Resources, Information 1. Narragansett, Rhode Island: Pell Marine Science Library, May 1969.

The first of a series of monthly bulletins on marine-related activities and issues that affect the six New England states. It is published by the New England Marine Resources Information Program.

77. New England Marine Resources, Information 2. Narragansett, Rhode Island: Pell Marine Science Library, June-July 1969.

A bulletin discussing one method of solid waste disposal at sea, favored by Harvard and University of Rhode Island researchers, that does not pollute the environment.

78. New England-New York Inter-Agency Committee. The Resources of the New England-New York Region. Part Two, Chapter X (Maine Coastal Area). 1954/1955.

A study representing part of the Technical Report of a larger work on New England-New York Region Resources. It deals exclusively with the Maine coastal area. Included in its survey are the topics of economic development, water supply and resources, plans for pollution control, power development, and land, recreation, fishery and wildlife resources.

79. New Hampshire State Planning Office. Economic Impact of Recreation, Vacation and Travel on New Hampshire. (New Hampshire State Planning Project, Report No. 9). July 1965.
An estimate and appraisal of the recreation-tourist activity in the state as related to the recreation market, recreation-tourist serving businesses, vacation home ownership, and the contributions of these activities to the state's economy.

80. New Hampshire State Planning Office. The New Hampshire Outdoor Recreation Plan. (New Hampshire State Planning Project, Report No. 13). October 1965.
An evaluation and analysis of present outdoor recreational resources and facilities in the state with recommended activities for future utilization.

81. New Jersey. Hackensack Meadowlands Development Commission. Hackensack Meadowlands Reclamation and Development Act. 1969.
A digest, map and print of an act which provides for the reclamation, planning, development and redevelopment of the Hackensack Meadowlands.

82. New Jersey Comprehensive Outdoor Recreation Plan, Summary Report. New Jersey: Department of Conservation and Economic Development.
A report synopsizing a series of interrelated studies comprising the New Jersey Comprehensive Outdoor Recreation Plan. The plan analyzes the major aspects of outdoor recreation and provides background data for comprehensive planning for future development of the State's recreational facilities.

83. New Jersey Department of Conservation and Economic Development. New Jersey Comprehensive Outdoor Receation Plan, Report 10, The Action Plan. New Jersey: Department of Conservation and Economic Development.
An in-depth study of the urgent need for more recreation land and developed facilities for the State and an outline of a 6-year State program to meet that demand.

84. New Jersey Department of Conservation and Economic Development. New Jersey's Shore - An Inventory and Analysis of Land Use. February 1966.
A study of the Jersey shore to evaluate its capacity in meeting present and future recreational requirements.
One of the few available studies focusing on coastal recreation, this study presents a broad range of recreational problems and conflicts in a recreation-oriented economy and outlines possibilities for future development and planning.

85. New York Department of Conservation. New York Statewide Comprehensive Outdoor Recreation Plan, Municipal Responsibility. October 1966.
The second of a three-part report by the State on outdoor recreation planning. This volume discusses local administration and responsibility, and reports on the resources, supply, demand, needs and action programs for municipal outdoor recreation.

86. New York Department of Conservation. New York Statewide Comprehensive Outdoor Recreation Plan, State Responsibility. May 1966.
The first of a three-part report. This volume emphasizes planning at the State level, includes a brief description of local needs and programs, and makes reference to private outdoor recreation developments.

87. New York Department of Conservation. New York Statewide Comprehensive Outdoor Recreation Plan, The Role of Private Enterprise. October 1966.
The third of a three-part report. This volume considers the present and potential contributions of private enterprise and organizations to outdoor recreation.

88. New York State Office of Planning Coordination. Metropolitan New York District Office. Long Island Sand and Gravel Mining. July 1970.
A study of the Long Island sand and gravel industry. It summarizes current mining practices and land requirements and outlines recommendations for the industry's proper utilization of resources and land use.

89. O'Brien, James J. (Excerpts of remarks). Texts and Excerpts of Remarks by Speakers at the Recreational Boating Pollution Symposium. Washington, D. C. March 23-23, 1970. p. 7.
Comments on the significance of pollution from boat sources as compared to other sources.
Two discussions are noteworthy: one outlines the anticipated role of the Coast Guard in enforcement and administration of the Water Quality Improvement Act; the second considers the mechanics of enforcing the Boat Pollution Control Act in New York State.

90. Oceanographic Atlas of the North Atlantic Ocean, Section 1, Tides and Currents. Washington, D. C.: U. S. Naval Oceanographic Office, 1965.
Part of the U. S. Naval Oceanographic Office's series of atlases on all ocean areas. This section is devoted to tide and current information for the North Atlantic.

91. Odum, H. T.: Copeland, B. J.; and McHanan, Elizabeth, A. (eds.). Coastal Ecological Systems of the United States, A Source Book for Estuarine Planning. Moorhead City, North Carolina: University of North Carolina, Institute of Marine Sciences, 1969. 3 vols.

A comprehensive summary of the status of knowledge of coastal ecosystems in the United States. The book identifies, characterizes and documents examples of each important type of system and makes general recommendations for further study and management.

92. Offshore Mineral Resources, A Challenge and an Opportunity. Second Report of the President's Panel on Oil Spills. Washington, D. C.: Government Printing Office, 1969.

A summary of findings and recommendations by the President's Panel on Oil Spills concerning offshore mineral resources development.

93. Ortolano, Leonard. Quality Standards for the Coastal Waters of Long Island, New York. A Presentation to the Marine Resources Council, Nassau-Suffolk Regional Planning Board under Sea Grant Project GH-63, National Science Foundation. Hartford, Connecticut: The Center for Environment and Man, Inc., April 1970.

A report on the nature and use of water quality standards in relationship to the coastal zone management of Nassau and Suffolk Counties. It discusses the process and manner in which water classifications are used, features of New York State's water quality standards, how the Counties' coastal waters are classified, and whether the waters meet their use classification.

94. Ortolano, Leonard and Brown, Philip S., Jr. The Movement and Quality of Coastal Waters: A Review of Models Relevant to Long Island, New York. Hartford, Connecticut: The Center for the Environment and Man, Inc., July 1970.

A report, prepared for the Marine Resources Council of the Nassau-Suffolk Regional Planning Board, focusing on models that are potentially applicable to the Long Island coastal environment and its problems.

95. Our Nation and The Sea, A Plan for National Action. Report of the Commission on Marine Science, Engineering and Resources. Washington, D. C.: Government Printing Office, January 1969. 4 vols.

A broad study of the Nation's marine environment. Current and proposed marine activities are reviewed and evaluated. The report is offered as a recommended national marine program and a governmental reorganization plan.

Some 122 recommendations are presented on the national capability in the sea, management of the coastal zone (22 recommendations), marine resources, the global environment, techncial and operating services and the organization of a national ocean effort. The most significant recommendations call for a restructuring of federal non-defense agencies with major marine missions under a proposed National Oceanographic and Atmospheric Agency reporting directly to the President. The most significant coastal zone recommendations call for federal grant assistance to the coastal states to stimulate the creation of comprehensive coastal planning and management focused at the state level with higher and lower levels of government playing supporting roles. Panel reports in three volumes supplement the basic report.

96. Outdoor Recreation Uses of Coastal Areas. (New England Marine Resources Information Program Publication No. 1). Narragansett, Rhode Island: Pell Marine Science Library, June 1969.
A broad review of the nature and dimensions of the problem of marine recreation and the general direction of solutions. Specific attention is given to the coastal zone where the recreational resource base is centered.

97. Parker, Frank L. and Krenkel, Peter A. Thermal Pollution: Status of the Art. Nashville, Tennesses: Vanderbilt University, National Center for Research and Training in the Hydrologic and Hydraulic Aspects of Water Pollution Control, December 1969.
A report discussing the effects of temperature on aquatic organisms and on water quality in general. Consideration is given to the beneficial effects of heat additions as well as to a comparison of the various methods of cooling water, i.e., towers, and their associated advantages and disadvantages.

98. Peter, Walter G. III. "New York Bight: A Case Study, Part I". Bioscience. Vol. 20, No. 10, May 15, 1970. pp. 617-619.
An article, first of a two-part report, examining the conflict between the U. S. Army Corps of Engineers and U. S. Congressman Richard Ottinger regarding the problem of pollution in the New York Bight caused by prolonged dumping operations. A brief summary is given of the report on pollution conditions existing in the Bight prepared by the Sandy Hook Marine Laboratory of the U. S. Bureau of Sports Fish and Wildlife for the Corps.

99. Peter, Walter G. III. "New York Bight: A Case Study, Part II". Bioscience. Vol. 20, No. 11, June 1, 1970. pp. 669-671.
The second part of a report on waste disposal effects in the New York Bight. This section focuses attention on the U. S. Army Corps of Engineers' policy in the light of the Sandy Hook study into the problem. It also discusses regulation and criteria for granting dumping and dredging permits, and questions the effectiveness of federal agencies in dealing with environmental protection.

100. Philip B. Herr and Associates. Final Report, Cape Cod National Seashore Impact Study. Boston, Massachusetts: Philip B. Herr and Associates, 1969.

An analysis of the Lower Cape region since the establishment of the Cape Cod National Seashore in 1961. The economic impact upon the area is examined and potential effects are projected.

This comparative economic assessment of the impact of the national seashore on six towns of the Lower Cape revealed marginal, rather than fundamental, changes in the local economy. Effects were chiefly on land values, and showed little effect on jobs, population and taxation.

101. Planning for Lower Manhattan. New York, New York: Downtown-Lower Manhattan Association, Inc., 1969.

A report on the growth and continuing expansion of the Lower Manhattan area outlining both long-term and shore-term proposals for future development. Recommendations cover improvements in mass transit, pedestrain and vehicular traffic, parking, and land use.

102. Port Development Expenditure Survey, United States, Puerto Rico, Canada, with a supplement on Latin America. (January 1, 1946 to December 31, 1965, including projections January 1, 1966 to December 31, 1970.) Washington, D. C.: The American Association of Port Authorities.

A survey of North American port development covering a 25-year period (including projections for January 1966 to December 1970). The survey compiles and analyzes data on capital expenditures for marine facilities in principal ports of the U. S., Puerto Rico, Canada and Latin America.

103. Port of New York Authority. The Port of New York Authority Facilities.

Aerial photographs and brief statistical data describing the terminals and transportation facilities of the Port of New York Authority.

104. Proceedings, Joint Conference on Prevention and Control of Oil Spills. (Publication 4040). New York, New York: American Petroleum Institute, 1970.

Technical papers and major addresses presented at a conference on oil spill prevention and control co-sponsored by the FWPCA and the American Petroleum Institute. Objectives of the conference were to define the overall dimensions of the oil spill problem, explore the present state-of-the-art, and review relevant research and development efforts of government and private industry, both here and abroad.

105. Reid, George K. Ecology of Inland Waters and Estuaries. New York: Reinhold Publishing Corporation, 1961.

An introduction to the elemental factors and processes that operate in lakes, streams, and estuaries as dynamic systems. Organized into five parts, the book covers (1) origins and features of basins and channels, (2) the nature of water, (3) natural waters as environment, (4) organisms in the environment, and (5) relationships of organisms and environment.

106. Rhode Island Development Council. Rhode Island Recreation Guide Plan. June 1965.

A program for the use, management, development and preservation of the natural and cultural resources of the state. It is intended to serve as a guide for action for all levels of government as well as for private property owners.

107. Rhode Island Report of the Governor's Committee on the Coastal Zone. Calvin B. Dunwoody, Chairman. March 1970

A study of the state's coastal zone. It outlines the zone's characteristics, relationship with governmental agencies, and activities and related problems of land and water use. It also analyzes the need for a resources management system and provides attendant recommendations.

108. Rhode Island Statewide Comprehensive Transportation and Land Use Planning Program. Public Right-of-Way to the Shore. March 1970.

A study expanding on the data contained in an earlier report (1958) on discovering the public rights-of-way to water areas of the state. The study is divided into three sections and an appendix. Part I summarizes the case law and legislation relating to the public rights-of way. Part II is an inventory and analysis of the rights-of-way for each municipality. Part III recommends further legislative and administrative actions. Aerial photographs and descriptions of each right-of-way constitute the appendix.

109. Rorholm, Niels, et al. Economic Impact of Marine-Oriented Activities-A Study of the Southern New England Marine Region. (Economics of Marine Resources, No. 7) Kingston, Rhode Island: University of Rhode Island, 1967.

A report analyzing the economic impact of commercial enterprises that depend upon the near-ocean environment for their existence in a given locale. The report uses the Southern New England Marine Region as its case study area.

110. Schuyler, Sonja and Heimerdinger, George. Continental Margin Data Collection, Pilot Project. (Unpublished manuscript). Washington, D. C.: Department of Health, Education and Welfare, 1970.

A study to determine the extent and availability of a data bank on U. S. continental margins that could be used by HEW's Bureau of Solid Waste Management for reference purposes. The National Oceanographic Data Center conducted the study using two pilot areas, one on the East Coast and one on the West Coast.

111. Sherk, J. Albert, Jr. and Cronin, Eugene L. The Effects of Suspended and Deposited Sediments on Estuarine Organisms. An Annotated Bibliography of Selected References. Washington, D. C.: U. S. Army Corps of Engineers, April 1970.

A set of abstracts and summaries of references on field and laboratory studies of the biological effects of suspended loads and deposited sediments in estuaries. Material which deals specifically with coastal engineering projects and offshore dumping of sewage sludge is included. A bibliography of bibliographies follows the annotated section.

112. Smith, F. A., et al. Fourteen Selected Marine Resource Problems of Long Island, New York: Descriptive Evaluations. Hartford, Connecticut: The Travelers Research Corporation, January 1970.

This report identifies and evaluates fourteen previously defined problems of the coastal marine environment that are cause for concern on Long Island. The problems include wetland destruction, domestic/industrial wastewater disposal, thermal and oil spill pollution, pesticides, and solid waste and dredging-spoil disposal.

113. Southeastern Regional Planning and Economic Development District Overall Economic Development Program. Taunton, Mass.: Southeastern Regional Planning and Economic Development District, August 1969.

An evaluation of the Economic Development District Agency in the southeastern part of Massachusetts. The agency's responsibilities include law enforcement planning, highway review, housing, pollution control study and direct services to municipalities and community groups. The report analyses the work of the Agency and recommends areas that need further support.

114. Spinner, George P. A Plan for the Marine Resources of the Atlantic Coastal Zone. American Geographical Society. 1969.

An examination of coastal marine resources with an emphasis on the need to formulate new coastal wetland preservation programs.

The text discussed the legal and economic aspects of coastal marine resources, some specific examples of competing uses of the coastal zone and their consequences, and goals for preservation of the marine resource habitat. This is a comprehensive review of the status of the marine resources of the Atlantic coastal zone.

115. Spinner, George P. "The Wildlife Wetlands and Shellfish Areas of the Atlantic Coastal Zone. Serial Atlas of the Marine Environment. (Folio 18). New York City, New York: The American Geographical Society, 1969.
A series of maps showing national and state wildlife refuges, locally and privately owned conservation areas, and shellfish waters of the Atlantic Coastal Zone.

116. Stover, Lloyd V. "Opportunities in the Sea, Forecast of World Ocean Objectives -- and When They Will be Reached". Ocean Industry. August 1970. pp. 22-26.
A broad overview of oceanic trends.

117. Study of Means to Revitalize the Connecticut Fisheries Industry. General Dynamics Corp. Electric Boat Division. January 1968.
A review of the present status of the commercial fishing industry in the State. An estimate of the value of sport fishing to Connecticut is given; the present scope of the industry is described; the finfish market is evaluated; mariculture and agriculture opportunities are outlined; and, government legislation affecting fisheries is considered.

118. Systems Analysis and Research Corporation. Regional Transportation Needs. A report for the New England Regional Commission. Cambridge, Mass.: Systems Analysis and Research Corp., November 1968.
A study broadly surveying New England's transportation facilities and requirements. It analyzes the transportation industry's response to these requirements and makes recommendations on public policy in the transportation field.

119. The Maine Coast, Prospects and Perspectives. Brunswick, Maine: Center for Resource Studies, Bowdoin College, 1967.
A book containing speeches presented at a symposium on the Maine coast. It includes discussions on economics; protection of shore and wildlife; local, regional and state planning measures; and, various action programs.

120. The Oil Spill Problem. First Report of the President's Panel on Oil Spills. Washington, D.C.: Government Printing Office.
A report presenting panel recommendations and findings for controlling oil spills beginning with a research and deployment program. It stresses ecological research and methods for containment and disposal; describes some of the environmental effects of spilled oil; and outlines the need for federal, regional, international and industrial regulation.

121. Trident Engineering Associates, Inc. Chesapeake Bay Case Study. Springfield, Virginia: Clearinghouse, September 1968. PB 179 844.

A study of the major uses of the Bay. The study focuses on present problems of the Bay, its current uses and conflicts, and previous efforts to control and improve its resources. The study evaluates these efforts and provides specific recommendation for the future.

122. Tri-State Transportation Commission [Connecticut, New Jersey, New York]. Managing the Natural Environment, a regional plan for water, sewage, air and refuse. March 1970.

A report considering the problems of air and water pollution, solid-waste disposal and water supply for the Tri-State Region. It evaluates the need for a regional monitoring system.

123. Tri-State Transportation Commission [Connecticut, New Jersey, New York]. Outdoor Recreation in a Crowded Region. September 1969.

A report summarizing extensive studies of recreational needs for the Tri-State Region and providing a park and recreation plan to meet future requirements.

124. Tri-State Transportation Commission [Connecticut, New Jersey, New York]. Regional Development Guide, Goals and Plans for the Tri-State Region. October 1968.

An outline of proposed long-range goals for regional planning and development for the Tri-State Region.

125. "Undersea dredge beats out floating competition". Engineering News Record. July 9, 1970. p. 24.

An article describing the use of an undersea crawlcutter dredge for excavating sand offshore for a beach nourishment project in Florida.

126. U.S. Comptroller General. Examination into the Effectiveness of the Construction Grant Program for Abating, Controlling, and Preventing Water Pollution. Washington, D.C.: Government Printing Office, 1969.

An examination into the effectiveness of the construction grant program of the Federal Water Pollution Control Administration for abating, controlling and preventing water pollution.

The report concludes that the system of awarding construction grants on a readiness-to-proceed basis is much less efficient than a system of awards based upon a project's contribution to the attainment of approved water quality use standards. The report advocates regional systems analysis and provides several examples, the most notable being on the Merrimack River in New Hampshire and Massachusetts.

127. U.S. Congress. House. Laws of the United States Relating to Water Pollution Control and Environmental Quality. Committee Print (91-93), 91st Cong., 2d sess. July 1970.
An up-to-date compilation of legislation developed by the U.S. House of Representatives' Committee on Public Works in the field of water pollution control and environmental quality. The compilation includes the Federal Water Pollution Control Act and its numerous amendments, the National Environmental Policy Act of 1969, and the Environmental Quality Improvement Act of 1970.

128. U.S. Congress. House. Offshore Oil Pollution. H. Doc. No. 91-340, 91st Cong., 2d sess. May 20, 1970.
A message from President Nixon transmitting recommendations for Congressional action to reduce the risks of oil pollution.

129. U.S. Congress. House. Our Waters and Wetlands: How the Corps of Engineers Can Help Prevent Their Destruction and Pollution. H.R. No. 91-917, 91st Cong., 2d sess. 1970.
A study by the U.S. House of Representatives' Committee on Government Operations. The study examines several aspects of the U.S. Army Corps of Engineers' role in carrying out its responsibilities for protecting the nation's water areas and recommends how the Corps can lessen pollution.

130. U.S. Congress. House. Phosphates in Detergents and the Eutrophication of America's Waters. H.R. No. 91-1004, 91st Cong., 2d sess. 1970.
A critical examination of eutrophication caused by phosphorus. Phosphate in detergents is considered the major contributor to eutrophication. Focus is on the detergent industry's arguments favoring use of detergents with phosphate, rebuttals to those arguments, and final recommendations by the Committee for finding and developing substitutes for phosphates in detergents.

131. U.S. Congress. Senate. The National Estuarine Pollution Study. Doc. No. 91-58, 91st Cong., 2d sess. March 1970.
A technical evaluation of the estuarine zone, examining the relationship of the bio-physical, socio-economic, and institutional environments within it. The report identifies scientific knowledge gaps, inventories available knowledge, and recommends a management program for the nation's estuarine resources.

132. U.S. Department of Agriculture. Soil Conservation Service. Cape May Plant Materials Center. Long Range Program for the Cape May Plant Materials Center. Hyattsville, Maryland: U.S. Department of Agriculture, Soil Conservation Service, 1966.
An outline of the long-range program for the Cape May Plant

Materials facility. The program will carry out the plant materials activities of the Soil Conservation Service's water and soil conservation program.

133. U.S. Department of the Army. Guidelines for Evaluating Estuary Studies, Models and Comprehensive Planning Alternatives. August 1969.

Guidelines and methodology for determining the best methods of study and organization for estuarine water resources planning. The pros and cons of "conventional" methods, mathematical models, electric analogues and hydraulic models are considered. Factors in determining the appropriate role of various federal and state agencies in estuary investigations are also considered along with cost-sharing of estuary investigations among federal and non-federal entities.

The general conclusion is that at the outset of a study a careful articulation of the type of results required should be made. Once this is done, a method or combination of methods can be tailored to the requirements in a cost effective and possibly cost-benefit way.

134. U.S. Department of the Army. Coastal Engineering Research Center. Shore Protection, Planning and Design. (Technical Report No. 4). Washington, D.C.: Government Printing Office, June 1966.

A report on the techniques currently used in shore protection planning and design. One part covers functional planning considerations including physical factors and littoral processes, and another outlines structural design features and analysis.

135. U.S. Department of the Army. Corps of Engineers. Harbor and Port Development, A Problem and an Opportunity. July 1968.

A look at various factors that can influence harbor and port development including cargo handling, vessel size and physical restraints, and a consideration of the impacts of these changes upon future planning.

The report suggests that cooperative interagency and industry studies be initiated to evaluate what should be done nationally and regionally to capture opportunities implicit in the rapidly changing marine transportation industry.

136. U.S. Department of the Army. Corps of Engineers. North Atlantic Division. National Shoreline Study, North Atlantic Region (DRAFT). August 1970. 2 vols.

A broad picture of bay and coastal shoreline conditions in the North Atlantic Region. The report emphasizes coastal area descriptions and shore histories, discusses state and local programs for shore protection, and consideres current methods and ecological factors.

Very useful information is provided on beach locations and length, erosion intensities, and ownership and use patterns. When combined with similar regional inventories of the entire U.S. shoreline, this report will form the first of four parts of the overall National Shoreline Study. Other parts are shore protection guidelines, shore management guidelines, and the Chief of Engineers report.

137. U.S. Department of the Army. Corps of Engineers. Pollution Studies for Interstate Sanitation Commission. New York Harbor Model, Hydraulic Model Investigation. (Miscellaneous Paper No. 2-558). Vicksburg, Mississippi: U.S. Army Engineer Waterways Station, February 1963.
A description of dye tests undertaken to establish dispersion characteristics of effluents discharged from major sewage treatment plants that contribute to pollution in New York Harbor.

138. U.S. Department of the Army. Corps of Engineers. Waterborne Commerce of the United States, Calendar Year 1968. Part 1, Waterways and Harbors, Atlantic Coast. Washington, D.C.: Government Printing Office, 1970.
Statistical data on the movements of commodities and vessels at ports and harbors and on the waterways of the Atlantic Coast. Military cargo moved in Department of Defense vessels is excluded.

139. U.S. Department of Commerce. County and City Data Book 1967. A Statistical Abstract Supplement. Washington, D.C.: Government Printing Office, 1967.
A variety of statistical information, most of which was derived from censuses, on population, housing, governments, business, mineral industries and agriculture.

140. U.S. Department of Commerce. Bureau of the Census. Statistical Abstract of the United States, 1970. Washington, D. C.: U.S. Bureau of the Census, 1970.
A compilation of official statistical data of national scope condensed primarily from reports of federal agencies.

141. U.S. Department of Commerce. Maritime Administration. The Economic Impact of United States Ocean Ports. Washington, D. C.: Government Printing Office, 1966.
An examination of the economic value of U.S. ocean ports on a state-wide and nation-wide basis. The examination includes contributions to domestic employment, commerce, industry and international trade attributable to the ports and their related activities.

142. U. S. Department of Commerce. Maritime Administration. Office of Ports and Intermodal Systems. Summarization of "Economic Impact" Studies and Reviews Performed by or for Various Ports. May 1970.
A brief outline of economic impact studies conducted by various ports. The studies include the NAR ports of New York, Philadelphia, Baltimore and Virginia as well as many ports elsewhere such as Milwaukee, Houston, San Diego and Seattle.

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A brief description of our national water and waste management problem and the resources needed to implement an adequate pollution control program.

144. U. S. Department of the Interior. Bureau of Outdoor Recreation and the National Park Service. Gateway National Recreation Area, A Proposal.
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A bulletin discussing the purposes, conditions, and funding of various fish and wildlife restoration acts.

146. U. S. Department of the Interior. Bureau of Sport Fisheries and Wildlife. Sport Fishing - Today and Tomorrow. (ORRRC Study Report 7). Washington, D. C.: Government Printing Office, 1962.
A part of a survey of the nation's outdoor recreation resources. This study examines fishing as a form of recreation in the U. S. Topics include current status of fishing waters, problems of supply, management policies, and the future of sport fishing in 1976 and 2000.

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Findings of a preliminary study of the water quality of the Delaware River Estuary, based on an investigation of the natural environment, the economic environment of wastewater inputs, present water quality and present water uses. The study proposes six alternative sets of goals for improving water quality with estimates of costs and benefits, and presents guidelines for implementation and for further study requirements.

148. U. S. Department of the Interior. Federal Water Pollution Control Administration. Proceedings of the Conference on the Pollution of Raritan Bay and Adjacent Interstate Waters. Third Session, New York. June 13-14, 1967. Vol. 1.

The proceedings of a conference about Raritan Bay and its adjacent waters. The purpose of the conference was to determine the existing pollution situation, to review the progress being made in controlling it, and to lay a basis for future action by all parties concerned.

149. U. S. Department of the Interior. Federal Water Pollution Control Administration. The Economics of Clean Water. Washington, D. C.: Government Printing Office, March 1970. 3 Vols.

The third report to Congress on the national requirements and cost of water pollution control, in four parts. The first is a summary of major findings and conclusions of the analysis; the second, Vol. I, contains the details of the analysis; Vol. II is a profile of animal wastes; and the fourth and last section, Vol. III, is an industrial profile of the inorganic chemicals industry.

150. U. S. Department of the Interior. Federal Water Pollution Control Administration. Water Quality Criteria. Report of the National Technical Advisory Committee to the Secretary of the Interior. Washington, D. C.: Government Printing Office, April 1968.

A report to help state and federal agencies determine water quality standards. The report discusses water use requirements for recreation and aesthetics; public water supplies; fish, wildlife and other aquatic life; and, agricultural and industrial uses.

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A description of the Federal Water Quality Administration's past activities and future plans for control of water pollution with an outline of its various programs for the next decade. Included are regulatory and assistance programs, planning and basic studies, and areas of research, development and demonstration.

152. U. S. Department of the Interior. Fish and Wildlife Service. Interim Report on Needs, Problems, and Possible Solutions Related to Fish and Wildlife Resources in the North Atlantic Region. July 1970.

A report on the present and future needs of people in the North Atlantic Region as they relate to fish and wildlife resources, the problems in meeting these needs, and possible solutions to these problems, especially as they relate to potential water development projects.

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A major report on estuaries describing and evaluating (1) selected management studies in specific estuaries, including Great South Bay and Chesapeake Bay, (2) estuarine landscape, (3) economic factors, (4) technical impacts, (5) conflicts and problems, (6) existing methods of federal-state coordination, (7) laws and tax policies, (8) state plans and policies, and (9) existing public management schemes.

The principal thrust of the report is the urgent need to preserve and restore estuarine fish and wildlife resources, associated commercial fishing and outdoor recreation activities, and aesthetics and natural areas, rather than the broader spectrum of uses contemplated in an overall management system.

The report examines the desirability and feasibility of establishing a nationwide system of estuarine areas. It concludes that it is not possible to select a limited number of estuaries or estuarine areas to constitute a nationwide system such as the National Park System. Implying that the delineation might trigger increased abuse of estuaries not selected, the report concluded that all estuarine areas of the nation should be included in any nationwide system.

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A brief summary of various surveys of Connecticut's coastal wetlands conducted during the past decade.

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160. U. S. Water Resources Council. The Nation's Water Resources. Washington, D. C.: Government Printing Office, 1968.
A comprehensive report evaluating the nation's water and related land resources, describing the problems in their management and ues, and outlining future water supply requirements and problems by region. One of the region's is the North Atlantic Region.
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